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ON THE PRESENCE OF FLUORINE AS A TEST FOR THE FOSSILIZATION OF ANIMAL BONES.

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The discovery of the existence of fluorine in animal bones was made by Morichini in the early years of the nineteenth century, and was soon thereafter confirmed by the leading chemists, although there were considerable discussions and some disputes in regard to its presence. Berzelius in his *Traitè de chimie*, Vol. VII, page 473, 1833, reports having certainly found it in animal bones, but says it was less than two per cent. About the same time, Gay Lussac, in his lectures before the Faculty of Science, says that the fluoride of calcium exists in the proportion of about one one-hundredth in the composition of bone and the enamel of teeth. On the contrary, in 1843, Girardin and Priesser, in their *Memoire sur les os anciens et fossiles*, in the *Annales de physique et de chimie*, 1843, Vol. III, page 370, declare that they have not been able to find the least trace of fluoride of calcium in ancient human bones, and that the existence of this salt in recent animal bones is more than doubtful. But this difference was all put to rest and beyond doubt by the investigations of Mons. Fremy in his *Recherches chimiques sur les os, Annales de physique et de chimie*, 1855, Vol. I, page 47. But it was, as they

say, in a quantity so small that the most delicate mechanism and operation were required to find it, and emphasizing this on page 70, he declines to give any analytic method by which he can determine the exact quantity of this salt in the bones tested. The results of analyses of Von Bibra were to the same effect. Heintz believes that he had found in the ash of the human femur from three to five per cent of the fluoride of calcium; while Zaleski made it less than one per cent.

The discoveries of prehistoric man in later times has rendered this investigation of greater interest than ever before. No prehistoric anthropologist of serious application, but has greatly desired some test which might even, in a measure, determine the relative, if not the actual, antiquity of bones found in prehistoric graves. To these persons it will be welcome news that the discoveries of the existence of fluorine in different proportions in recent bones and those of antiquity will furnish a test of their respective ages, however slight and uncertain it may be. It may be only partial, cannot be depended upon in all cases, but will be, nevertheless, a source of gratification if it be a step towards the solution of a controverted point. It may be freely conceded that animal bones deposited in one locality may possess a greater quantity of flourine than they would have if deposited in another. The condition of their surroundings, the presence and association of different salts may produce a decided effect upon the results. But there may be cases in which these differences do not exist, and hence, this test may be invoked with considerable benefit. A deposit of human and animal bones may be mingled together, the fossilization of the latter may be determined from other knowledge of their antiquity, while the deposit, being in the same locality, subjected to the same conditions, having the presence of the same chemical constituents, the difference in fluorine of the various bones may afford in some degree, possibly slight, a test as to the antiquity of human bones. Such a test and comparison was sought to be made by the writer in the case of the deposit of animal bones found at Natchez by Dr. Dickeson. Along with them was a fragment of a human pelvis. While they were not actually touching

each other, they were practically so—they were in the same position, same deposit, and, so far as is possible to determine, subject to the same chemical influences: therefore, a comparison between the two ought to give an idea of their comparative ages.

These bones are shown in one of the alcoves of the Museum of the Academy of Natural Sciences, Philadelphia. They are fossil bones of extinct animals of the plistocene period. In color, texture and general outward appearance they have a remarkable similarity as though they belonged together. They are well preserved, firm in texture, and of a dark chocolate-brown color which has been attributed to ferruginous infiltration. They consist of a nearly entire skull of *Megalonyx jeffersonii*, teeth of the *Megalonyx dissimilis* and the *Ereptodon priscus*, bones of the *Mylodon harlanii*, bones and teeth of the *Mastodon americanus*, and teeth of *Equus major* and *Bison latifrons*. Along with them is the os innominatum of a human subject. The question affecting the antiquity of man is whether these subjects, the bones of which were found together, were, when alive, contemporaneous, and whether the evidence of age in one is evidence of age in the other. They were all presented to the Academy by Dr. Dickeson at the meeting in October, 1846; description thereof is to be found in the Proceedings of the Society for that year, vol. iii, p. 106. Dr. Dickeson reported at that time that they were discovered by him in a single deposit at the foot of the bluff in the vicinity of Natchez, Mississippi. He says, "The stratum that contained these organic remains is a tenacious blue clay that underlies the diluvial drift east of Natchez, and which diluvial deposit abounds in bones and teeth of the *Mastodon giganteum;* that they could not have drifted into the position in which they were found is manifest from several facts, first that the plateau of blue clay is not appreciably acted on by those causes that produce ravines in the superincumbent diluvium; second, that the human bone was found at least two feet below the three associated skeletons of the *Megalonyx*, all of which, judging from the position or proximity of their several parts, had been quietly deposited in this locality, inde-

pendent of any active current or other displacing powers; and lastly, because there is no mixture of diluvial drift with the blue clay, which latter retains its homogenous character equally in the higher parts which furnished the extinct quadrupeds and in its lower part which contained the remains of man." These specimens thus found associated were made the subject of investigation by Sir Charles Lyell, and afterwards by Dr. Joseph Leidy, the latter having published a memoir with illustrations of the human bone in the Transactions of the Wagner Free Institute of Science, vol. ii, p. 9. He says, "It differs in no respects from an ordinary average specimen of the corresponding recent bone of man."

Dr. Leidy says Lyell expressed the opinion that, although the human bones may have been contemporaneous with those of the extinct animals with which it has been found, he thought it more probable that it had fallen from one of the Indian graves and had become mingled with the older fossils which were dislodged from the deeper part of the cliff, and Dr. Leidy adds: "In the wear of the cliff the upper portion, with the Indian graves and human bones, would be likely to fall first, and the deeper portions with the older fossils, subsequently on the latter."

Although Dr. Leidy testifies to the general similarity of appearance of the human with the other bones, it does not seem to have occurred to him to have them analyzed and compared. Remembering the story told by the analysis and consequent comparison of the Calaveras skull with that of the rhinoceros teeth found in a formation corresponding in age, though in a different locality; and of the fact apparent therefrom that the Calaveras skull was in an equally advanced stage of fossilization as the rhinoceros teeth, I deemed it wise to make an examination and test by analysis. To this end I applied to Prof. Angelo Heilprin, and through him to the authorities of the Philadelphia Academy of Natural Sciences, so a few months since specimens certified by Prof. Heilprin have been taken, one from the bone of the man and the other from one of the bones of the mylodon, choosing those which, for size, texture and general appearance, bore the greatest likeness one

to the other. These were submitted by me to Mr. Hildebrand, a Chemist of the United States Geological Survey, on duty at the National Museum, who furnishes the following result of his analysis.

Two Fossil Bones.

		Man. Per cent.	*Mylodon.* Per cent.
Loss at 100°C.		4.55	6.77
Loss on ignition		16.54	21.18
Silica	($Si O_2$)	22.59	3.71
Phosphoric acid	($P_2 O_5$)	17.39	23.24
Alumina	($Al_2 O_3$)	3.21	4.02
Iron protoxide	(Fe O)	5.65	4.44
Manganese protoxide	(Mn O)	1.65	3.40
Lime	(Ca O)	25.88	30.48
Magnesia	(Mg O)	0.95	0.78
		98.41	97.02

"Alkalies, carbonic acid and fluorine were not looked for, owing to the small amount of available material, hence the low summation."

The failure to test for fluorine is much to be regretted, and was the cause of a second application for a greater quantity with which to make another analysis. It will be reported further on in this paper.

The importance of this analysis will be apparent at a glance. The human bone is in a higher state of fossilization than is that of the Mylodon. It has less lime and more silica. In their other chemical constituents they are without any great difference. Of lime the bone of the Mylodon has 30.48%, while that of man has but 25.88%. Of silica the Mylodon has 3.71%, while man has 22.59%. I am well aware of the ordinary uncertainty of this test when applied to specimens from different localities and subjected to different conditions; but in the present case no such differences exist. The bones were all encased in the same stratum of blue clay, and were subjected

practically to the same conditions and surroundings. As one swallow does not make a summer so the discovery of one specimen does not prove the antiquity of man; but it is to be remarked that upon each discovery and in almost every investigation the evidence found points towards higher antiquity of man and tends to show the occupation of the earth by prehistoric man to be more and more extensive. This discovery is simply a fact to be put down to the credit of the high antiquity of man. We should proceed in the same direction to discover other evidences, to investigate the value of those already found; and as they accumulate, each one, or all together, should be given their fair value, in the endeavor to arrive at a truthful conclusion, independent of *a priori* theory or preconceived idea.

The possibility of the determination of the relative antiquity of human bones found in prehistoric graves has set the chemists and prehistoric anthropolgists to an investigation of the fluorine test. Mons. Zaborowski presented a paper before the Academy of Sciences at Paris on the 1st of May, 1893, upon the differences in the chemical composition between two skeletons alleged to be prehistoric, those of Thiail and of Villejuif. These analyses were made by Mons. Adolphe Carnot, Engineer-in-Chief of Mines, and a professor of the Superior School of Mines, Paris. The result of these analyses was to show that the skeleton of Villejuif was much the oldest of the two and that it accorded well with other ancient bones which, from their surroundings and associations, were definitely determined. In the Bulletins de la Societe d'Anthropologie of Paris, Vol. IV, No. 6, the Seance of 18th of May, page 309, Mons. Emile Riviére gave the results of his investigations, comparisons and analyzations of alleged prehistoric bones belonging to the deposit of Billancourt. The excavations of this deposit have been pursued by Mons. Riviére during the seven years from 1875 to 1882, and the extinct fauna which he had obtained therefrom consisted of *Elephas primigenius*, *Rhinoceros tichorinus*, *Cervus megaceros*, *Tarandus rangifer*, *Bos primigenius*, etc. There were also found in one of the river drifts in the immediate neighborhood of Billancourt, the re-

mains or fragments of two human skeletons. These human bones were transmitted to the museum with the suggestion that they belong to the same epoch and, consequently, were of the same antiquity as the deposit of Billancourt, although MM. Riviére and Gaudry, judging from the aspect, texture, density and, in fact, in all their physical characters, were of a contrary opinion. This last proposition was combatted by several members of the Congress, and it was insisted that the human bones were contemporaneous with the ancient animal bones. These bones were afterwards, and for the purpose of settling or aiding at least in settling the disputed question, submitted to Mons. Carnot, who reported in his analysis that fluorine in the human tibia was but $\frac{17}{100}$ of one per cent, while in the animal bones it was found in quantities of one per cent and $\frac{43}{100}$. Mons. Carnot reports that, taking the average of the specimens, the presence of fluorine in the animal was from seven to nine times greater than that in the human skeleton, and that the human skeleton contains nothing or but slightly more than was to be found in modern bones; and his conclusion was that the human bones were much more recent. Mons. Carnot has given the results of his investigation, the manner of the conduct of his experiments, his method of analysis, and his opinion of the whole matter in a recent paper in the *Annales des Mines*, 2nd Bulletin of 1890, page 155.

The remainder of this paper is, for the most part, a translation of that of Mons. Carnot which, made by the present writer, has very kindly been revised for correction of chemical terms and formulæ by Prof. R. L. Packard.

Process of Analysis pursued and recommended by M. Carnot.— Bones are composed partly of mineral and partly of organic matter. We are to deal only with the mineral, but must first determine the amount or proportion of the organic matter, and to this end the specimen to be operated upon is calcined at a moderate temperature, in such way as to preserve only the ashes or burnt bones. The caustic lime produced by calcination is converted into carbonate of lime by the addition of carbonate of ammonia, evaporation and calcination near 200 degrees before weighing the ashes. By taking the weight of

fragments of bone well washed and dried, then the weight of the ashes, the difference may be considered as representing the the weight of organic matter.

The ash of modern bones is formed of the following elements: tribasic phosphate of lime in the largest proportion, with a small quantity of phosphate of magnesia, very little fluoride and chloride of calcium, carbonate of lime, very little peroxide of iron and of aluminum and, finally, an extremely small proportion of alkaline salts, as chlorides, sulphates and, possibly phosphates.

In the fossil bones we will see that the proportions of phosphate and of carbonate of lime vary, that those of magnesia and of chlorine change very slightly, while the fluoride of calcium is in a greater and more important quantity. There is often much more oxide of iron and sometimes phosphate of iron, sometimes crystallized silica, frequently a little sand or clay, and finally, in certain cases, sulphate of lime and pyrites.

Complete Analysis.—This operation, performed upon modern bones, comprises the following:

1.—Determination of fluorine.
2.—Determination of chlorine.
3.—Determination of carbonic acid.
4.—Determination of phosphoric acid and the bases (lime, magnesia, alumina, and oxide of iron).

1. *Fluorine.*—The determination of fluorine is performed in the method described in detail in the *Annales des Mines*, 1st number; 1893, page 130; the general features of which, however, are as follows: The decomposition of the fluoride in presence of a great excess of silica by concentrated sulphuric acid, in an apparatus entirely dry, with a slow current of dry gas running through it; the transformation of gaseous fluoride of silicon into fluosilicate of potassium, which is collected, washed, dried and weighed. If the chlorine is in a quantity not to be neglected, it is absorbed by passing the current of gas through pumice impregnated with sulphate of copper and heated until the dehydration is complete. The same reagent

will arrest sulphuretted hydrogen when the calcined matter contains a sulphide which is decomposed by sulphuric acid. If there be organic matter which can evolve sulphurous acid, the latter can be retained by the use of caustic lime freshly calcined. In the case of substances containing iodine, it is moved by means of the copper turnings placed before the sulphate of copper. In determining fluorine, 5 grams of the ash of modern bones to 2 grams of fossil bones are employed in such way as to always have a convenient quantity of fluosilicate of potassium to determine on the balance.

2. *Chlorine.*—For the determination of chlorine a special operation is performed, treating one or two grams of ash by cold nitric acid slightly diluted. When the solution is complete, we add water and nitrate of silver. The weight of chloride of silver dried, will give the proportion of chlorine.

3. *Carbonic Acid.*—The proportion of carbonic acid enabling us to calculate the carbonate of lime is obtained by attacking from two to four grams of ash by nitric acid in a small flask exactly weighed and provided with a tube containing pumice saturated with sulphuric acid (*paunce*) to retain humidity. At the end of the operation, the carbonic acid is replaced by dry air by aspiration, and the apparatus is weighed. The loss of weight represents the carbonic acid disengaged.

4. *Phosphoric Acid, Lime, Magnesia, Alumina, and Oxide of Iron.*—Two grams of ash are used in this operation. Dissolve in hydrochloric acid and heat in a capsule of platinum a sufficient length of time to drive out the fluorine. The solution diluted with water, is then filtered, afterwards saturated by ammonia until the commencement of precipitation of phosphate of lime, then redissolved by acetic acid added little by little in slight excess in such a manner as not to produce a noticeable heating of the liquid.

Phosphate of iron is precipitated in this way alone or with phosphate of aluminum. If this precipitate is almost insignificant, we take the weight after washing and ignition and according as (1) the absence or (2) the presence of aluminum is observed, we calculate by the following formula the weight

of the different elements (without separating the iron and aluminum):

(1.) $P_2O_5Fe_2O_3=p$, $P_2O_5=0,47p$, $Fe_2O_3=0,53p$.
(2.) $P_2O_5(^{Fe_2O_3}_{Al_2O_3})=\acute{p}$, $P_2O_5=0,50\acute{p}$, $(^{Fe_2O_3}_{Al_2O_3})=0,50\acute{p}$.

If the precipitation is somewhat voluminous, the elements are determined by separating the phosphoric acid by molybdate of ammonia. The acetic liquid, from which phosphate of iron and aluminum has been removed, is diluted to 200 cubic centimetres. Exactly the half is then taken to determine the lime, the magnesia and the phosphoric acid; the other half is put in reserve to verify the result in case of need. The addition of oxalate of ammonia, neutral and pure, will determine the precipitation of lime, which is separated as oxalate and is determined as caustic lime, carbonate or sulphate of lime. The filtered liquid, supersaturated with ammonia, is left in repose during 24 hours and gives a precipitate of ammoniomagnesium phosphate, of which the weight, after ignition, enables us to calculate the magnesia and a part of the phosphoric acid.

$$P_2O_5 2MgO=p_1, \quad 2MgO=0,36p_1, \quad P_2O_5=0,64p_1$$

The rest of the phosphoric acid is precipitated in the final solution by the magnesia mixture, and is determined as $P_2O_5 2MgO$.

Rapid Methods.—In the large series of modern and fossil bones which have been examined, it would have taken a long time and been, perhaps, without benefit to make the complete analysis. In most cases it is sufficient to make, along with the qualitative analysis, the exact determination of fluorine as fluosilicate of potassium and the rapid determination of phosphoric acid by means of a standard solution of uranium. This operation is executed in the following manner: 2 grams of the ash are dissolved in hydrochloric acid, and the liquid is neutralized and the phosphate of iron or iron and aluminum separated as before described, of which we take 47 or 50 per cent. to represent the weight of the phosphoric acid. Almost

all the phosphoric acid is found in the acetic solution with which we proceed to a volumetric test. It is unadvisable to pour into the acetic solution the standard solution of uranium, because the latter will cause some phosphate of lime to precipitate with the phosphate of uranium and we should, in consequence, find too small a proportion by measuring the volume of uranium solution employed.

We arrive at a more exact result by making the determination by the indirect method: We dilute the liquid to 200 cubic centimetres, then pour it, with the aid of a graduated burette, into a measured volume of a standard solution of nitrate of uranium, to which is added a little acetate of soda slightly acidified by acetic acid and the solution is heated to near 80 degrees. We stop when one drop of the liquid, placed on a porcelain saucer, in contact with a little ferrocyanide of potassium in powder, will cease to give a brown color. In order to standardize the solution of uranium, we operate in the same manner, starting with an exactly known weight of phosphate of lime. By taking phosphate of lime exactly analyzed, we succeed better than by taking pure phosphate of soda, because we standardize and make the determination in conditions which are identical. We add pure water to such extent that 40 cubic centimetres correspond exactly to O.200gr. of phosphoric acid (or 1 cubic centimetre to O,005gr. of P_2O_5). The operation should be performed a second time for verification. In the assay of a phosphate, if one operates on 2 grams and makes the acetic solution up to 200 cubic centimetres, we can calculate the proportion of phosphoric acid from the volume V of the liquid which will have saturated the 40 cubic centimetres of the solution of uranium. The volume contained O.200gr. of phosphoric acid. As a consequence, in 1 gram of phosphate, or 100 cubic centimetres of the liquid, there would be Ogr, $200 \times \frac{100}{V}$ (V being expressed in cubic centimetres).

The following table gives the results of analyses for a certain number of bones of varied origin.

These analyses confirm at nearly all points the conclusions that M. Fremy has drawn from his numerous analyses. We remark with him as to the constancy in the proportions of

phosphate and carbonate of lime in genuine bones, whether we compare the different parts of the same bone, the different

	Human—Body of Femur.	Human—Head of Femur.	Ox, Tibia.	Manatee rib—Modern.	Elephant Femur—Modern (Siam).	Elephant tooth, Dentine.	Elephant tusk, Ivory.	Bones of Grand Serpent.	Trionyx Shell.	Testudo radiata.	Crocodile.	Varan a deux Bandes (Monitor).
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
$P_2O_5 3CaO$	87,45	87,87	85,72	81,82	90,03	86,87	82,08	89,80	80,37	81,87	87,67	87,32
$P_2O_5 3MgO$	1,57	1,75	1,53	2,62	1,96	3,82	15,72	1,91	1,46	1,49	1,05	1,69
$CaFl_2$	0,35	0,37	0,45	0,63	0,47	0,43	0,20	0,43	0,27	0,35	0,33	0,57
$CaCl_2$	0,23	0,30	0,30	0,36	0,20	0,20	traces	0,20	0,10	0,16	0,34	0,24
$CaOCO_2$	10,18	9,23	11,96	14,25	7,27	7,27	2,04	7,41	16,58	15,80	10,69	9,88
Fe_2O_3	0,10	0,13	0,13	0,15	0,15	0,15	0,08	0,15	1,09	0,13	0,17	0,12
	99.98	99,65	100,09	99,83	100,08	100,11	100,12	99,90	99,87	99,80	100,25	99,82

bones of the same individual, or the bones of animals of different species. The same observation can be made for the proportion of fluoride of calcium which appears always to fall within the limit from $\frac{1}{3}$ to $\frac{1}{2}$ per cent. Chloride of calcium is almost always in less quantity than fluoride; it is the same with the oxide of iron except in the shell of the turtle trionyx (IX). It is necessary, nevertheless, to notice some exception in this constancy of proportion in bony substances of special nature, like the teeth or tusk of the elephant and the shell of the turtle. The phosphate of magnesia, almost always less than 2 per cent, is raised to near 4 per cent in the tooth of the elephant (VI) and passes 15 per cent in the tusk of the elephant (VII) of which it contributes, possibly, to augment the compactness and resistance. At the same time the carbonate of lime which often forms more than 9 per cent of the substance of bone, drops to 2 per cent in the ivory. The carbonate of lime is sensibly in superior proportion in the average of bones of herbivorous animals, and above all, in those that live in water, the manatee and the turtle (IV, IX, X).

The principal object of this paper has been to compare modern bones with fossil bones of similar species in order to discover the relative amount of fluorine and phosphoric acid, and to that end numerous analyses have been made, the results of which can better be given in the form of a table.

The first column of figures gives the proportion of phosphoric acid, the second the proportion of fluorine, the third gives the calculated *ratio* of this proportion of fluorine to that of an apatite having an equal amount of phosphoric acid.

Bones of Modern Animals.	Phosphoric Acid.	Fluorine.	Proportion calculated for apatite.
Human Femur—Body	40,91	0,17	0,05
Human Femur—Head	41,20	0,18	0,05
Human rib	36,80	0,22	0,06
Bone of Ox	40,10	0,25	0,07
Bone of Calf	40,32	0,23	0,06
Bone of Elephant	41,24	0,23	0,06
Tooth of Elephant—Dentine	41,77	0,21	0,05
Modern Ivory	46,12	0,10	0,02
Bone of Manatee	38,93	0,31	0,09
Bone of Dugong	38,03	0,27	0,08
Bone of Rytina gigas	39,52	0,24	0,07
Bone of White Swan	38,20	0,19	0,05
Shell of the Trionyx	37,54	0,13	0,04
Bone of Testudo radiata	38,30	0,17	0,05
Bone of large Serpent	42,16	0,21	0,05
Bone of Crocodile	40,88	0,16	0,04
Bone of Varanus	40,91	0,28	0,07
Bone and Spine of Turbot	40,96	0,11	0,05
Bone and Spine of Codfish	41,27	0,24	0,06
Bone and Spine of Pike	38,26	0,16	0,05

It can be seen from this table that the amount or quantity of Fluorine in these modern bones is always between 0,16 and 0,31 p. 100, while the amount of phosphoric acid in the same is between the limits of 37 and 42 p. 100 (the ivory being an exception). The relation between the amount of fluorine with that of phosphoric acid in the normal apatite is found to be between 0,05 and 0,07 per cent, the exact average for the 20 analyses being 0,058.

Fossil Bones.—The following tables give the result of corresponding tests upon fossil bones, for comparison and to observe the modification produced by fossilization:

Complete Analysis.	1. Bone of Manatee, found in the peat deposits of Scania, Sweden. Plistocene Geol. Epoch.	2. Bone of Ox, from a Plistocene deposit in Cindre, Department of Allier, France.	3. Bone of Manatee from a Tertiary deposit, Tongrien stage, at Etrechy, Seine et Oise	4. A Vertebra of the Ichthyosaurus, from the Kimmeridgian clays of the Jurassic period; Havre, Seine Inferieure.	5. A silicified bone of a reptile from Bayreuth,* belonging to the Triassic period.	6. Debris of Fish from a breccia in the inferior silurian of Canon City, Rocky Mts., U. S. A.
Phosphate of Lime	64,63	79,05	68,53	12,90	.....	67,70
Phosphate of Magnesia	1,97	0,65	2,27	.....	.....	.....
Phosphate of Iron ($P_2O^5F^2eO^3$)	9,63	1,34	8,68	1,23	0,62	.....
Peroxide of Iron	.....	.....	.....	.....	.....	7,10
Fluoride of Calcium	0,88	1,70	3,82	3,42	traces	5,31
Chloride of Calcium	0,44	0,48	0,30	.....	.....	.....
Carbonate of Lime	21,20	15,98	15,68	51,56	.....	15,01
Silica	0,75	0,10	0,35	.....	.....	.....
Sulphide of Iron (FeS^2)	.....	.....	.....	24,92	.....	.....
Sulphate of Lime	.....	.....	.....	4,23	.....	.....
Silica and Clay	.....	.....	.....	1,57	.....	.....
Quartz	.....	.....	.....	.....	98,45	.....
Organic matter	.....	.....	.....	.....	.....	5,67
Loss on ignition	.....	.....	.....	.....	0,88	.....
Total	99,50	99,30	99,63	99,83	99,95	100,79

*Note.—There remained of this only a thin crust of phosphate of iron, the central part was formed of crystals of quartz enveloped in a gray-blue quartzose mass, traversed by gray veins that served to bind together the phosphated envelope.

It is to be remarked that the first four analyses report only the mineral portion of the substance, the organic matters having first been abstracted; while in the last two, the organic

matter has been reported. The relative proportions between the fluorine and phosphoric acid will be set forth further on in these tests or assays and are classed according to their geologic deposits.

It is deemed proper to cite other tables made by other chemists and reported from standard works. This for the purpose of comparison:

Fossil Bones after Girardin and Preisser, reported in the *Annales de Physique et de Chimie*, 1843, Vol. 3, p. 370.

	Hygroscopic Water.	Organic matter.	Phosphate of Lime.	Phosphate of Magnesia.	Phosphate of Iron.	Carbonate of lime.	Fluoride of Calcium.	Silica.	Alumina.	
1. Metacarpal of Fossil Bear, Cavern of Mialet, Gard	1.30	7.17	75.45	2.81	.....	12.18	1.09	.....	.....	100
2. Tusk of Fossil Elephant, Alluvial deposit at Saint Pierre sur Dives. (Calvados.)	.....	traces	75.91	3.15	.....	18.40	2.64	.....	.....	100
3. Vertebra of the *Plesiosaurus dolichodeirus* from the Oxfordian clay at Dives, Jurassic	2.20	4.80	54.20	4.61	6 40	10.17	2.11	9.21	6.30	100
4. Large bone of the *Poekilopleuron bucklandii*, quarries of Maladrerie, calcaire of Caen, Jurassic	.....	1.30	71.12	.....	0.12	25.31	0.86	1.29	.....	100
5. *Ichthyosaurus*—Rib-bone, from the Dives clay	.....	1.34	46.00	1.00	16.11	31.09	1.02	3.21	.....	100
6. *Ichthyosaurus*—Rib-bone, from the chalk chlorite	.....	8.19	76.00	1.08	0.70	10.00	0.12	3.01	.....	100
7. *Ichthyosaurus*, skull, from the Jurassic	0.60	7.07	70.11	1.45	.....	17.12	1.65	2.00	.....	100
8. Bone of Manatee, from tertiary deposits near Valogne (Manche)	.....	.....	76.40	.....	5.71	0.97	9.12	7.80	.....	100
9. *Otaria jubata* (?) Straits of Magellan, S A	.....	1.17	61.19	0.95	.....	14.48	22.21		.....	100

It is to be noted that the last number given for the fluoride of calcium shows that the exactitude of these analyses are not always to be depended upon.

Fossil Bones after Mons. Fremy. *Annales de Physique et de Chimie*, 1858, Vol. I, p. 88.

	Ash.	Phosphate of Lime.	Phosphate of Magnesia.	Carbonate of Lime.	Silicious matters, and Fluoride of Calcium.	Organic matter.
1. A fossil Ox from Caverns of d'Oreston: the metatarsus with exterior part having the aspect of wood	80.4	71.1	1.5	11.8	.....	10.3
2. The same—interior having become friable	80.6	71.5	1.7	11.3	.....	11.0
3. The same—spongy part	84.2	6.33	1.2	5.2	17.2	8.0
4. Vertebræ of fossil Rhinoceros from Sansan, (Gers.).	83 4	5.90	.....	41.3	2.6	traces
5. The same—ribs	83.1	6.68	.....	27.5	1.4	traces
6. Long Bone of fossil Hyæna from Cavern of Kirkdale	75.5	72.0	1.3	4.7	.....	20.0
7. Dorsal Vertebra of fossil Rhinoceros	69.5	25.7	0.4	57.5	8.5	
8. Humerus of same	73.0	32.4	0.4	64.0	6.2	.....
9. Teeth of same	90.4	65.2	0.7	13.8	14.5	.....
10. Tusk of the fossil Mastodon	90.4	56.5	0.7	13.1	24.3	.....
11. Bone of fossil Bear—solid part	83.9	59.7	0.4	23.6	9.8	.....
12. The same—spongy part	76.7	23.1	1.2	67.5	14.0	.....
13. Fossil Armadillo, scales	80.7	55.0	0.4	23.8	12.4	.....
14. *Anoplotherium*, fossil—vertebra of the tail	84.0	53.1	0.4	20.4	19.4	.....
15. Vertebra of the fossil Turtle	87.0	61.1	0.7	10.6	18.6	.....

Observations.—The present composition of these fossil bones results both from their initial composition at the epoch when they belonged to the living animals, and the alterations incident to the diverse influences of atmosphere, soil and water during a long series of centuries. Comparing the results of these analyses of different modern animal bones, results with but feeble divergencies, we are authorized to believe that it was the same in past time and that the initial composition of the bone was practically uniform. The influences which have operated upon the fossil bones since they were buried in sedimentary deposits have produced modifications which are more or less important and quite varied. The proportion of organic matter has always been much diminished; from 35 to 40, which seemed to be the original proportion, it has descended in the process of fossilization from 6 to 12 per cent. These differences testify at the same time to the permeability of the earth by air and water, of infiltration and to the degree of compactness or porosity of the different bones or to the different parts of the same bone. The modification in the organic mat-

ter of the bones has not been examined, but the reader is recommended to an interesting study upon that subject by Mons. Scheurer-Kestner in the *Bulletin de la Societe chimique*, 1870, Vol. I, page 199, and Vol. II, page 11.

As for the mineral substances of these bones, the difference is sometimes small, but other times large from the initial composition. The proportion of carbonate of lime is generally increased, although in a measure extremely variable. The amount of phosphate of lime has frequently diminished, whether by reason of solution and infiltration of water or by the formation of phosphate of iron. The magnesia is found in proportion nearly identical to those which exist in the bones of living animals. The bones have always retained a notable quantity of iron, whether in the state of hydrate of peroxide which colors them a reddish-brown, or in the state of phosphate of peroxide, rarely in the state of ferrous phosphate. The reducing actions have sometimes determined the deposit of sulphide of iron under the form of pyrites inattackable by hydrochloric acid. This has taken place notably in the vertebra of the *ichthyosaurus* from the Kimmeridgian clays of Havre. There is sometimes found in these bones, a certain quantity of sulphate of lime. The calcination with organic matter could give rise to the sulphur. The bones contain frequently a small quantity of clay or of silica in the form of quartz. They are also, though rarely, almost entirely transformed into crystalline or crystallized quartz; such is the case with the specimen from the trias at Bayreuth.

The chlorine is almost always in slight proportion in the fossil bones as well as in the modern, especially if one has taken care to eliminate by washing the soluble chlorides, and to leave only the chloride of calcium combined with the phosphate of lime. Fluorine is found always in a greater and more important quantity corresponding to several hundredths of fluoride of calcium. This salt forms with the phosphate of lime a nearly insoluble compound comparable to apatite; it appears to augment, in a certain measure, with the antiquity of the bones, so that one is able, up to a certain point, to find in the relative proportion of phosphoric acid and of fluorine, an index to the degree of fossilization.

 (*To be continued.*)

EXPERIMENTAL EVOLUTION AMONGST PLANTS.[1]

By L. H. Bailey.

De Varigny has written a most suggestive book upon Experimental Evolution, in which he contends for the establishment of an institution where experiments can be definitely undertaken for the purpose of transforming a species into a new species. "In experimental transformism," he writes, "lies the only test which we can apply to the evolutionary theory. We must use all the methods we are acquainted with, and also those, yet unknown, which cannot fail to disclose themselves when we begin a thorough investigation of the matter, and do our utmost to bring about the transmutation of any species. We do not specially desire to transform any one species into another known at present; we wish to transform it into a new species. . . . Experimental transformism is what we need now, and therein lies the only method we can use."

This is a most commendable object, and I hope that the attempt will be made to create a new species before our very eyes. This is what most people demand as a proof of evolution, and they are sometimes impatient that it has not been done; and it would seem, upon the face of it, that nothing more could be desired. When I reflect, however, upon the fact that this very thing has occurred time and again with the horticulturist, and consider that botanists and philosophers persist in refusing to see it, I am constrained to offer some suggestions upon De Varigny's excellent ambition. If I show a botanist a horticultural type of recent or even contemporaneous origin which I consider to be specifically distinct from its ancestors, he at once exclaims that is not a species but a horticultural variety. If I ask him why, he replies, "Because it is an artificial production!" If I show him that the type is just as distinct from the species from which it

[1]Abstract of an address before the Massachusetts Horticultural Society, Boston, Feb. 23, 1895.

sprung as that species is from its related species, and that it reproduces its kind with just as much certainty, he still replies that, because it is a horticultural production it cannot be a species. In what, then, does an accidental horticultural origin differ from any other origin? Simply in the fact that one takes place under the eye of man and the other occurs somewhere else! It is impossible at the present day to make a definition of a species which shall exclude many horticultural types, unless an arbitrary exception is made of them. The old definitions assumed that species are special creative acts, and the method of origin is therefore stated or implied in all of them. The definition itself, therefore, was essentially a statement of the impossibility of evolution. We have now revised our definitions so as to exclude the matter of origin, and thereby allow free course to evolution studies; and yet here is a great class of natural objects which is practically eliminated from our consideration because, unhappily, we know whence the forms came! Or, to state the case differently, these types cannot be accepted as proofs of the transformation of species because we know certainly that they are the result of transformation!

Now, just this state of things would be sure to occur if De Varigny were to transform one species into another. People would say that the new form is not really a species, because it is the result of cultivation, domestication and definite breeding by man. He could never hope to secure more remarkable transformations than have occurred a thousand times in the garden; and his scheme—so far as it applies to plants—is essentially that followed by all good gardeners. Or, if the prejudices of critics respecting the so-called artificial production of species could be overcome, he could just as well draw his proofs of evolution from what has already been done with cultivated plants and domesticated animals, as from similar results which might arise in the future from his independent efforts. I am not arguing against the scheme to create a species before our eyes, but I am simply stating what has been and is the insurmountable difficulty in just this line of endeavor—the inability of the experimentor to satisfy some scientific men that he has really produced a species; for it is a singular thing

that whilst all biologists now agree in defining a species upon its tangible and present characters, many of them nevertheless act upon the old notion that a species must have its origin somewhere beyond the domain of exact history.

This notion that a species, to be a species, must have originated in nature's garden and not in man's, has been left over to us from the last generation—it is the inheritance of an acquired character. John Ray, towards the close of the seventeenth century, appears to have been the first to use the word species in its technical natural history sense, and the matter of origin was an important factor in his conception of what a species is. Linnæus' phrase is familiar: "We reckon as many species as there were forms created in the beginning." Darwin elaborated the new conception—that a species is simply a congregation of individuals which are more like each other than they are like any other congregation—and with a freedom from prejudice which is rarely attained even by his most devoted adherents, he declared that "one new variety raised by man will be a more important and interesting subject for study, than one more species added to the infinitude of already recorded species." The old naturalists threw the origin of the species back beyond known causes; Darwin endeavored to discover the "Origin of Species," and it is significant that he set out without giving any definition of what a species is. I have said this much for the purpose of showing that it is important, when we demand that a new species be created as a proof of evolution, that we are ourselves open to the conviction that the thing can be done.

I have said that no modern naturalist would define a species in such terms that some horticultural types could be excluded, even if he desired that they should be omitted. Haeckel's excellent definition admits many of them. In his view, the word species "serves as the common designation of all individual animals or plants, which are equal in all essential matters of form, and are only distinguished by quite subordinate characters." It is impossible, however, to actually determine if one has a species in hand by applying a definition. One must show that his new type—if it is a plant—has

botanical characters as well marked as similar accepted species have, and these characters must show, as a whole, a general tendency towards permanency when the plant is normally propagated by seeds. He must measure his type by the rule of accepted botanical practice. If the same plant were found wild, so that all prejudice might be removed, would the botanist unhesitatingly describe it as a new species? If yes, then we should say that a new species had been created under the hand of man; and this rule I wish now to apply to a very few familiar plants. In doing so, I do not wish to be understood as saying that I consider it advisable to describe these plants as species under the existing methods of botanical description and nomenclature, for, merely as a matter of convenience and perspicuity, I do not; but I wish to show that they really are, in every essential character, just as much species as very many other universally accepted species are.

[The speaker then produced numerous instances of the evolution of forms of garden plants, in various genera, which are as distinct from their parents and from each other as accepted species of the same genus are; and these forms are as permanent, when multiplied extensively through many years by means of the seeds, as these wild species are. "Here we have absolutely new and unique types, as De Varigny demands, and they are as distinct from each other and from their parents, in accepted botanical characters, as 'good species' in the same genus are from each other, and they perpetuate these characters as unequivocally as those species do. Moreover, we know definitely what their origins were, and they therefore answer all the purposes of experimental evolution.

"All this is but another illustration of how tenaciously botanists still hold to the Linnæan idea of species, whilst they profess the Darwinian idea."]

I have now brought to your attention a few familiar plants for the purpose of showing that what are, to all intents and purposes, good species have originated in recent years; and that, whilst botanists demand that the origination of species within historic times shall constitute the only indisputable proof of organic evolution, they nevertheless refuse to accept

as species those forms which have thus originated and which answer every demand of their definitions and practice. The proofs of the evolution of species, drawn from the accepted practice of the best botanists themselves, could be indefinitely extended. We need only recall the botanical confusion in which most cultivated plants now lie, to find abundant proof of the evolution of hundreds of types so distinct that the best botanists have considered them to be species; but other botanists, basing their estimate of species upon origins, have reduced them or reincluded them into the form or type first described. Consider the number of species which have been made in the genus Citrus, comprising the various oranges, lemons, limes and the like. Recall the roses. The moss-rose and others would be regarded as distinct species by any botanist if they were found wild and if they held their characters as tenaciously as they do under cultivation. In fact, the moss-rose was long regarded as a good species, and it was only when its origin began to be understood that this opinion was given up. The earlier botanists, who were less critical about origins than the present botanists are, made species largely upon apparent features of plants, although their fundamental conception of a species was one which was created, as we find it, in the beginning. Yet, strangely enough, we at the present day profess to regard species as nothing more than loose and conventional aggregations of similar individuals and which we conceive to have sprung from a common ancestor at some more or less late epoch in the world's history,—we make our species upon premises which we deny, by giving greater weight to obscurity of origin than we do to similarities of individuals.

The fact is that much of the practice of systematic or descriptive botany is at variance with the teachings of evolution. Every naturalist now knows that nature does not set out to make species. She makes a multitude of forms which we, merely for purposes of convenience in classifying our knowledge of them, combine into more or less marked aggregations to which we have given the name species. Now and then we find in nature an aggregation of successive individuals which

is so well marked and set off from its associated groups, that we think nature to have made an out and out distinct species; but a closer acquaintance with such species shows that, in many cases, the intermediate or outlying forms have been lost and that the type which we now know is the remainder in a continuous problem of subtraction. In other cases, it appears to have arisen without intermediate forms, as a distinct offshoot from an older type. This is well illustrated in many remarkably distinct garden forms, which originated all at once with characters new to the species or even to the genus. I have mentioned such a case in the Upright tomato. Even the sudden appearance of these strange forms is proof that species may originate at any time and that it can be no part of our fundamental conception of a species that it shall have originated in some remote epoch. Species-making forever enforces the idea of the distinctness and immutability of organic forms, but study of organisms themselves forever enforces an opposite conception. The intermediate and variable forms are perplexities to one who attempts to describe species as so many entities which have distinct and personal attributes. So the garden has always been the bugbear of the botanist. Even our lamented Asa Gray declared that the modern garden roses are "too much mixed by crossing and changed by variation to be subjects of botanical study." He meant to say that the roses are too much modified to allow of species-making. The despair of systematic botanists is the proof of evolution!

I repeat that mere species-making, in the old or conventional sense, is an incubus to the study of nature. One who now describes a species should feel that he is simply describing a variable and plastic group of individuals for mere convenience' sake. He should not attempt to draw the boundary lines hard and fast, nor should he be annoyed if he is obliged to modify his description every year. This loose group may contain some forms which seem to be aberrant to the idea which he has in mind; and it would seem as if he should be ready to call them new or distinct species whenever, from whatever cause, they become so much modified that it is convenient, for purposes

of identification and description, to separate them from the general type. Just as soon as botanists come to feel that all so-called species of plants are transitory and artificial groups maintained for convenience in the study of nature, they will not ask whether they are modified outside the garden or inside it, but will consider groups of equal distinctness and permanence to be of equal value in the classification of knowledge, wholly aside from the mere place of their origin. At the present time, the garden fence is the only distinction between many accepted species and many discarded ones. The cultivation of man differs from the methods of nature only in degree, not in kind; and if man secures results sooner than nature does it is only another and indubitable proof of the evolution of organic forms. It is certainly a wholly unscientific attitude to demand that forms originating by one of nature's methods are species, while similar forms originating by another method are beneath notice.

If species are not original entities in nature, then it is useless to quarrel over the origination of them by experiment. All we want to know, as a proof of evolution, is whether plants and animals can become profoundly modified under different conditions, and if these modifications tend to persist. Every man before me knows, as a matter of common observation and practice, that this is true of plants. He knows that varieties with the most marked features are passing before him like a moving panorama. He knows that nearly every plant which has been long cultivated, has become so profoundly and irrevocably modified that people are disputing as to what wild species it came from. Consider that we cannot certainly identify the original species of the apple, peach, plum, cherry, orange, lemon, wine grape, sweet potato, Indian corn, melon, bean, pumpkin, wheat, tobacco, chrysanthemum, and nearly or quite a hundred other common cultivated plants. It is immaterial whether they are called species or varieties. They are new forms. Some of them are so distinct that they have been regarded as belonging to distinct genera. Here is the experiment to prove that evolution is true, worked out upon a scale and with a definiteness of detail which the

boldest experimenter could not hope to attain, were he to live a thousand years. The horticulturist is the only man in the world whose distinct business and profession is evolution. He, of all other men, has the experimental proof that species come and go.

OBSERVATIONS ON A SO-CALLED PETRIFIED MAN.

By J. M. Stedman.[1]

With a Report on the Chemical Analysis.

By J. T. Anderson.[2]

On the 28th day of August, 1894, a human so-called petrified body was found by some workmen while repairing a public country road about one mile south of Tuskegee, Macon Co., Alabama. A few days later I heard of the find, and immediately proceeded to Tuskegee to make an investigation of the body and of the locality where it was found, and to obtain samples of the water, earth and body.

Through the kindness of Mr. J. S. Webb, who had the body in charge, I was enabled to make an examination on, and to procure portions of the body from the several places as samples. As Mr. Webb was trying to sell the body as a curiosity, he did not wish me to mutilate it any more than was necessary. I obtained, however, portions of the intestine, a section 75 x 25 mm. through the ventral abdominal wall, several pieces of muscle with tendon from the ankle, and a section 100 x 100 mm. was cut out from the dorsal region of the thigh and extending to the bone in thickness. Mr. Webb, by the way, offered me the body for the college museum for $75, but, as I hoped to be able to procure it later as a donation, I refused. He sold the body in a few days for $150, and it is now being exhibited in the villages and cities of the country, much to my regret.

The body is that of a Negro woman who was evidently rather fat. From two elderly gentlemen, who are now living in Tuskegee, and who remember the circumstances of the burial, I learned that the body was buried in 1837 in what was

[1] Professor of Biology in Alabama Polytechnic Institute, and Biologist of Experiment Station.

[2] First Assistant Chemist of Experiment Station.

then a small neglected country or family burying-ground, situated a few rods from the road. They also remember the burial, at about the same time, of an Indian but a few feet from this Negro; and I am trying to have the Indian dug up to ascertain whether it is likewise preserved or not.

In company with several citizens of Tuskegee I drove to the scene of the find. The burial ground is near the top of a very large flat hill or plateau, and a few rods south of the grave is a small marshy or swampy bog, while some seven meters to the east there is a spring. Several years ago the public road was moved a few rods to the south in order to give it a better grade up the hill, and as the small, neglected burial ground had not been and was not worth keeping up, and was no longer used as such, the road was cut through a portion of it; and most people had now forgotten about its existence. The road was cut about one meter below the surface, and the ditch at the side was directly over the Negro woman's body, and served to carry off the water from the spring just above. The result was that the body lay but about one-third of a meter below the ditch, and the water from the spring kept it continually wet, even when no water appeared on the surface. While the workmen were repairing the road and picking in the ditch, they hit something that proved to be a pine board. On removing it they came upon others, which they removed, and thus exposed a plain pine coffin in a remarkable state of preservation.

The soil where the body was found is sandy, with enough fine, light-colored clay and moisture to give it the appearance of mortar. When a portion of the soil was dried, it held together with great tenacity, and the dirt left on one's hands became nearly white on drying, and felt smooth and slippery like powdered talc; in fact, I could detect no difference as regards looks or feeling. Portions of the soil had streaks of red color, probably due to iron. The hole left by the removal of the coffin soon filled with water, the soil being extremely wet, although very little moisture appeared on the surface on account of excessive dry weather. The water had a decided milky appearance. I obtained samples of the soil from the bottom of the hole, from the sides, and from the earth just

above; and also samples of the water from the hole. These were placed in thoroughly clean jars brought for the purpose.

The first thing to be noted is the fact that the boards that covered the coffin, as well as the coffin itself, were in a perfect state of preservation—not a sign of decay was to be found. They looked like newly-planed boards that had been exposed to the weather for about six months; just long enough to partially color the wood gray. The nails in the coffin had all rusted away.

On opening the coffin, the body of the Negro woman was found to be in a remarkably good state of preservation. Of course it was saturated with water, but, nevertheless, it was firm like hard cheese, so that the workmen pronounced it petrified when they touched it, and found it would not give or bend. In general, the body at first glance has very much the appearance of sheet asbestos, being dirty-white in color, with a certain grain in places, due to the connective tissue in the fat where the skin is wanting. The abdomen and to a certain extent the thorax is swollen and bloated, so that part of the abdomen pressed tight against the top of the coffin, thus showing that decomposition had started when the body was first buried, and had continued for a short time. It is to be noted that no part of the body was decomposing when found, and it has shown no signs of doing so since; neither does it smell—all decomposition that had taken place was now checked. The head is not well preserved, part of the cranium having been decomposed, and other parts partially so, and more or less separated. All the hair, with part of the scalp is, however, well-preserved, while the face had been partially decomposed. One wrist and both ankles had been badly decomposed, and part of the feet and one hand slightly decayed. Some of the toe and finger-nails were perfect, others partially or wholly decayed. The rest of the body is practically intact and well-preserved, except that in places the skin is wanting; but this does not make itself apparent to the ordinary observer.

With a scalpel I cut through the ventral abdominal wall from right to left, and then cephalad at the two ends. The body at this place cuts very much like dense cheese. The cut

portion was then lifted up and turned back, thus exposing the viscera beneath. The intestines, and in fact all the viscera, were only partially preserved. They had become more or less decomposed, and had then been checked in their decomposition and preserved in that state from further change. There was no particular smell from the abdominal cavity, and no decomposition was in progress. The intestines were moist, loose and pliable, and the fœces still preserved in them. All the viscera were light in color, due to the partial deposition in them of the finely-suspended, and perhaps more or less soluble, mineral matter in the water that filled and covered the body. The deposit of this mineral matter was not in sufficient quantity to give the tissue much firmness.

The abdominal wall which was cut through in order to examine the viscera, was 30 mm. thick, and owed its dense, cheese-like consistency and firmness to the deposition in it of the finely suspended mineral matter contained in the water that constantly saturated the body. The abdominal wall was practically completely charged with the mineral matter, while the process of filling the viscera had but nicely commenced. The mineral matter was extremely fine and of a light or almost white color, and thus it was that the body appeared light. So far as I was able to determine, this mineral matter in the tissues of the body is the same as that held in suspension in the water, and which gave it the milky appearance; and also that which in the soil or sand gave it the appearance of mortar, and that when dry, looked and felt exactly like powdered talc. With the exception of the fat, the tissues of the abdominal wall were practically intact, the mineral matter simply saturating them and filling up all the spaces; in the fatty tissue, however, which composed a large part of the abdominal wall at this point, there had been more or less substitution of the mineral matter for the fat. This substitution was, roughly speaking, about half and half. Hence it was that where the skin was wanting, there appeared a grain, due to the connective tissue remaining, while the fat was partially substituted. Wherever the skin was preserved, the black pigment could be distinctly seen in a cross-section.

In cutting and then removing the 100 x 100 mm. piece from the back of the thigh, I was surprised to find that the deposition of mineral matter had taken place to the extent of 25 mm. in depth, and that from this point inward the muscular, connective and other tissues were in such a perfect state of preservation, that they looked and felt exactly like fresh corn-beef. The flesh or muscle was of a dark red color, and of a perfectly natural and fresh consistency, showing no signs whatever of having undergone the slightest decomposition; it did not emit any more odor than fresh meat. The perimyseum appeared perfectly natural, the tendons glistened as well as the perimyseum near them, and the connective tissue was, to all appearances, as strong and well preserved as one could expect to find it in a body dead but twenty-four hours. On teasing the muscles, the fasciculi held together perfectly naturally, and the only difference besides color that I could then detect between this muscle and a perfectly fresh one was that this appeared to have a little more firmness, but it was very slight, and if compared with fresh corn-beef this difference disappears. It is also to be noted that the external layer, averaging 25 mm. in thickness, where the deposit and substitution of mineral matter had taken place so completly, and which covered the entire body and gave it its consistency, that this region was quite sharply marked off from the region below. In other words, the deposition and substitution of mineral matter had taken place to the extent of about 25 to 30 mm. in depth all over the body (wherever examined it was of this depth), and rendered this portion very dense, tough and firm; and, instead of gradually merging into the soft almost unchanged inner portion, the change was quite abrupt. From an examination of the abdominal wall, I at first supposed this abrupt and sudden change to indicate and be due to the region of fatty tissue, but I found, on further examination, that the abrupt change took place in the muscular tissues of the thigh, where little or no fat was to be found.

On reaching my laboratory, I made a microscopical examination of the samples of tissue by means of sections and teased preparations, in order to determine the extent of the preserva-

tion of the histological structures. I found that the skin was nearly substituted by mineral matter in most places, and in some wholly substituted. The fatty tissue was also substituted by mineral matter to the extent of about 50%. The muscular tissue, where the deposit of mineral matter was greatest, did not seem to have been replaced to any considerable extent, but was simply saturated with the deposit. Where the muscles were still soft, the fasciculi, and even the fiber cells with their striæ, were remarkably well preserved and easily demonstrated. The perimyseum and tendons were practically perfect. The connective tissue was surprisingly perfect, the only change being the loss of the connective tissue corpuscles in many places; but even these were found in the better preserved soft muscular tissue. The nerves were not well preserved histologically. The blood-vessels in the soft muscles were fairly well preserved; the blood-corpuscles were not to be found. The periosteum and the bone was perfect, except in those regions like the head and ankles where decomposition had taken place.

I then examined, by the agar-agar plate culture method, the muscular tissue for bacteria, and found none. The water taken from the hole, left by the removal of the coffin, also failed to reveal the presence of bacteria on an agar-agar plate culture of 1 cc. of the water.

A piece of the soft muscular tissue from the thigh was then placed in a museum jar of water from the grave. This jar was opened every few days for more than a month, and the muscle taken out to show it to visitors. The water, jar or muscle had not been sterilized; no caution was taken, in opening the jar, to close it for some minutes, nor to protect the piece of flesh. I did this in order to determine how long it would keep under those conditions, and I therefore watched it and made examinations from time to time. To my surprise, the piece of muscle is this day, the 15th of December, 1894, of a reddish color and looks quite natural, but I now find, on examination, that it is becoming softer, and that bacteria have made their ap-

pearance, so that the tissue will ultimately decompose[3]. It was this test that I wished to finish that prevented me from publishing this article just as soon as the chemical analysis was completed.

The large piece cut from the thigh was placed in an empty museum jar in order to keep it as moist and natural as possible, and to observe how long it would thus resist decomposition. The piece was frequently taken out of the jar to allow visitors to examine it. I found, in about two weeks, that a small mould was making its appearance on the surface, and I then cut it in halves, and placed one in alcohol and the other on my table and allowed it to dry. Of course the specimen in alcohol is preserved, although it does not look natural; it has become darker colored, and the flesh has shrunken and become harder, while the hard external region of greatest deposition of mineral matter has become much softer. The specimen exposed on the table dried in a few days with the usual changes, and is now preserved in that state, and shows no signs of moulding or decaying. The entire body is now dry, and will keep, no doubt, indefinitely in that condition.

Of course the greatest interest attaches itself to the question of the cause that checked decay and preserved this body for 57 years, with the certainty, I might say, of doing so indefinitely, and, perhaps, of ultimately converting it into a hard fossil by substitution. It was with this object in view that I obtained samples of the water and earth from the grave, and gave them to Dr. Anderson for chemical analysis, and also portions of the body itself for chemical analysis. And, now that the analysis of all these has been made, I must confess I do not see my way clear. I cannot understand why decomposition should not have continued on the inside until the viscera and muscles were obliterated. The body seems to have acted like a filter, and to have taken out and held in itself the finely suspended, and perhaps also some soluble mineral substances in the water. This filtration naturally saturated the

[3] Since writing the above the proof has just reached me (11th of March, 1895), and as nearly three months have elapsed since the observation was made, it may be of interest to note that I have kept the sample of flesh on my desk ever since, and that it is to-day only partially decayed.

external layers of tissue first, and, when found, had not extended far inside. I think I can understand, then, why it is that the external tissues are preserved, but I do not understand the preservation of the inner tissues. I do not believe that the small amount of lead found in some portions of the body itself can account for the preservation. Can it be that the silica, alumina and oxide of iron held in suspension, and the silica, lime and magnesia in solution in the water could have prevented decomposition? The three ingredients, silica, alumina and magnesia constituted the bulk of the mineral substances deposited in the tissues, and that near the periphery, was in sufficient quantities to give it a firm consistency. The soil contained nearly 3% soluble silica, and the water contained a large percentage; but can this account for the preservation? The observed fact is that the body was preserved and decay completely checked, and I can only account for it by saying that the combined action of all the ingredients of the water—silica in suspension and in solution, alumina and oxide of iron in suspension, and lime and magnesia in solution—is to be looked upon as the cause.

And, what is still more obscure, is the fact that the body was buried with a shroud (or some clothes), while all that now remains of it is the imprint nicely stamped on that part of the abdomen that had swollen and pressed closely against the lid of the coffin, and also on the lid of the coffin where some of the mineral matter is adhering. Every thread of the cloth is as plainly visible in the impression as it is possible to make them with plaster casts. It appears to have been a cotton sheet, but not a fiber of the original cloth is to be found. Now, why was this cloth not preserved? If it was cotton cloth, its chemical composition was practically the same as that of the pine coffin which was perfectly preserved; if the cloth was woolen (there can be but little doubt that it was cotton), its chemical composition was practically that of the hair which was also perfectly preserved. I cannot account for this to my own satisfaction, and will offer no suggestions; to me, this is more difficult of explanation than the preservation of the body.

Through the kindness of Dr. Anderson, First Assistant Chemist on the Experiment Station, who made the chemical analysis of the water, soil and body, I am enabled to submit herewith his report on the same:

With a view of determining the agency by which the body was kept in so excellent a state of preservation, the soil in which the body was buried, the water which percolates through the soil from the spring above, and the flesh from the body itself were all subjected to chemical analysis.

The soil presents no peculiarity in its composition, further than it is a highly silicious soil. It contains 95.91% of insoluble residue, and 2.94% of soluble silica, thus giving nearly 99% of silicious matter. Next in importance as regards quantity comes alumina and oxide of iron—nearly 1%—and then lime, magnesia, and the alkalies in minute quantities.

When found, the coffin containing the body was submerged in water, and when the coffin was removed, the hole soon filled with water. A sample of this water was taken for analysis. After remaining in the bottle undisturbed for four or five weeks, a considerable sediment, chiefly of sand, formed in the bottom, but the supernatant liquid remained decidedly milky in appearance. The suspended matter which caused this milkiness was found to be silica and alumina, with oxide of iron. The water presented no other peculiarity, but contained lime and magnesia.

Naturally, the chief interest attaches to the chemical examination of the flesh itself. To preserve the specimen in the condition in which it was found, it was kept in a bottle with a ground glass stopper. Determinations were made of water, fat, organic matter other than fat, and ash. From a number of determinations the following averages are taken: Water, 55%; organic matter, 44%, 32% of which was fat; and ash, 1.22%. The least amount of mineral matter found was 0.33% and the largest, 2.10%. It was found to contain silica, alumina, oxide of iron, lime and magnesia. But, in my estimation, the most important find was lead. This was not found uniformly distributed throughout the specimen. From two to three grams of the flesh were used in each determination. In

two of these samples not a trace of lead could be found; in three or four others a perceptible quantity was obtained, while in one a sufficient quantity was gotten to make a metallic bead. There can be no doubt, therefore, that lead in some form exists in the body. It was found in a part of the specimen which had been kept several weeks in alcohol, and hence must have been incorporated with the tissues of the body.

Whether lead was the sole agency in the preservation from decay, I cannot say; but that it exerts an influence in that direction cannot, I think, be doubted. It is recorded that a solution of sugar of lead, among other things, were used as an embalming fluid during the Civil War. It is hardly probable that the body in question was embalmed, as it is that of a Negro; but some salt of lead may have been administered as a medicine. It is well-known that lead is a "cumulative" in its nature—that is, when taken into the system from time to time, even in small quantities, it is not thrown off as is usual, but is retained in the system and thereby accumulates. May not the presence of lead in the body under examination be accounted for in this way? It is a matter of regret that reliable facts relating to the history of the case before us are unattainable.

ON THE VALIDITY OF THE GENUS MARGARITANA.

By Chas. T. Simpson.

In 1817, Schumacher founded the genus *Margaritana*[1] for the *Mya margaritifera* of Linnaeus, the *Unio margaritifera* of subsequent authors, on account of the fact that, whereas the shells of the latter genus had both cardinal and lateral hinge teeth, this species had only the cardinals. Say's *Alasmodonta*, applied in 1818[2] to other Naiads having similar teeth, is synonymous. A number of forms have since been added to the groups, mostly by Dr. Lea, and, as it stands to-day, it includes some 26 or 27 species, all confined to North America, with the exception of the type, which is circumboreal.

The soft parts of the different members of this assemblage do not differ generically from those of *Unio*, and any separation from that genus can only be founded on the character of the teeth which I have mentioned. The Margaritanas do not, taken as a whole, form a natural group, but are, undoubtedly, polyphyletic in their origin, several of them being evidently much more nearly related to certain Unios than they are among themselves; and it is only reasonable to suppose, when the facts are all carefully considered, that most, if not all the species, have sprung from different groups of Unios.[3]

The genus *Unio* may be divided into a large number of sections, which are, I think, unworthy of subgeneric rank, but which consist of species that are shown to be closely related by characters of the animal and shell, by habits and the facts of their distribution. In a majority of these groups, though certain species may be considered fairly typical, a close relationship is shown to other groups by species which seem to stand

[1] Essai d'un Noveau Syst. des Habits, des vers Testaces, p. 137, 1817.

[2] Journ. Phila. Acad. Nat. Sci. I, p. 459, 1818.

[3] The earliest recorded species referred to Margaritana is, I believe, the *M. nebrascensis* Meek (Rep. of the U. S. Geol. Surv. of the Territories, Vol. IX, p. 114, 1876), from the Upper Missouri Cretaceous. The genus Unio is now believed to date back into the Triassic.

between and partake of the characters of two or more assemblages; sometimes to that degree that they might, with equal propriety, be placed in either of two or three sections. The same thing is true of the Margaritanas to some extent, and, while a few of the divisions of this so-called genus do not seem to be very closely related to anything else, others show such strong affinities to certain groups of Unios, that they will have to be placed with them in anything like a natural arrangement.

In the Mississippi Valley and on the Atlantic Slope, there is found a small group of Unios fairly typified by *U. pressus*, which consists of compressed, rather quadrate or rhomboidal shells, with strongly undulate beaks, and faintly rayed green epidermis. In the right valve of all these forms, the hinge plate is cut away directly under the beak, and there is a long, curved lateral, and a tolerably perfect, compressed cardinal, the latter separated from the edge of the shell by a deep, parallel sided socket. In the left valve is a somewhat triangular, recurved cardinal, which exactly fits into and fills up this missing area in the hinge plate of the opposite valve; another cardinal fills the parallel sided socket, and there are a couple of usually somewhat blurred laterals. In this group I should place *Unio pressus, tappanianus, charlottensis, neglectus*, and possibly one or two others.

Now *Margaritana rugosa* bears so strong an external resemblance to *Unio pressus*, that one is often taken for the other by persons familiar with the species; the principal difference being that the former is generally somewhat corrugated on the posterior slope, while the latter is without this sculpture, though this distinction does not always hold perfectly good. The arrangement of the teeth is precisely the same in both, but in the *Margaritana* the hinge plate is a little heavier, and the laterals are more blurred or imperfect. Dr. Lea carefully examined specimens of the animals of both, and it will be seen that they are very much alike by the descriptions which I give in his own language. Recently, Dr. V. Sterki, a careful anatomist of New Philadelphia, Ohio, who has dissected these species, has reached the conclusion that they are very nearly related.

LEA'S DESCRIPTION OF *Unio pressus* AND *Margaritana rugosa*.

Unio pressus Lea.	*Margaritana rugosa* Bar.
Branchial uterus occupies the whole of the outer branchiæ.	*Branchial uterus* occupies the whole of the outer branchiæ; brownish, forming a large, massive lobe which extends below the margin.
Branchiæ large, rounded below, free nearly the whole length of the abdominal sac.	*Branchiæ* very large, rounded below, the inner ones much the larger, free nearly the whole length of the abdominal sack.
Palpi small, subangular, united half way down the posterior edges.	*Palpi* rather small, subtriangular, united nearly one-half way down the posterior edges.
Mantle thin, slightly thickened on the margins.	*Mantle* rather thin, much thicker at the margin, blackish on posterier basal edge.
Branchial opening large, blackish on the edge, and with numerous papillæ.	*Branchial opening* rather large, with small, brown papillæ.
Anal opening rather small, blackish, and without papillæ[4].	*Anal opening* rather large, without papillæ.
Superanal opening rather large, united for some distance below, blackish on the edges.	*Superanal opening* very large, with a dark brown line within, united below.
Color of the mass dirty white.	Color of the mass salmon.
Embryonic shell subtriangular, light brown, has hooks.	Embryonic shell triangular, brown, has hooks.

[4] Agassiz claimed that two distinguishing characters of the genus *Margaritana* were (Archiv. fur Naturgeschichte, 1852, I, p. 41) that certain species had gills free from the mantle at their posterior extremities, and that the anal region was not fringed, while in the typical Unios the branchiæ and mantle were united posteriorly, and that both siphonal openings had papillae. According to this, *Unio pressus* and its allies, though having lateral teeth, would be Margaritanas.

It is probable that when Dr. Lea described these two animals, he never thought of their being closely related, yet, with a few trifling exceptions the description of one would answer for the other. In *Margaritana complanata*, which is a somewhat solider, more rounded species, there is essentially the same arrangement of the teeth, the beak sculpture is exactly like that of the group, and specimens are occasionally found which approach *Unio pressus* in form. *Unio charlottensis*, a member of this section, is shaped much like *Margaritana complanata*, and the characters of the animal of the latter show that it is closely related to the other species of the group.

In the section typified by *Margaritana margaritifera*, we have a set of Naiads all having elongated, usually arcuate shells, with black, rayless epidermis. They have commonly two more or less perfectly developed cardinals in the left valve, and one in the right; the hinge plate is elongated, narrow just behind the cardinals, but becoming heavier near the posterior end, and generally rounded on its inner face. All the species which I place in this group have a rather wide border of the prismatic outer layer of the shell projecting beyond the nacre, and which is plainly visible from the inside, and all occasionally have dark-colored blotches on the nacre. I include in it *Margaritana margaritifera* Linn., having a circumboreal distribution; *M. hildrethiana* Lea, of the central Mississippi region; *Unio monodontus*, found in the same territory as the last; *Unio decumbens* Lea, of Tennessee and Northern Alabama; *Unio hembelii* Con., of Louisiana; *Unio crassus* Retz., of Southern Europe, and *U. laosensis* Lea, of Southeastern Asia. In *Margaritana hildrethiana*, there are seldom any laterals, while *M. margaritifera* often has them more or less perfectly developed. A lot of the latter in the National Museum (Museum No. 60,878) from the State of Washington, have a single, well-developed lateral in each valve, while two specimens in the Lea collection, one from Maine (Mus. No. 86,285) and another from Massachusetts (Mus. No. 86,286) have as perfect cardinals and laterals as any *Unio*. *Unio monodontus* usually has the cardinals more or less blurred, and sometimes in old specimens they are reduced to mere tubercles or are even ob-

solete, while a good series of shells will show every variation from those with no laterals at all, to others in which they are perfect.

The latter species has been placed by some authors in *Unio* and by others in *Margaritana*. In *Unio decumbens* and *hembelii* there is a somewhat better development of laterals, though they are often not quite perfect, while in *U. crassus* and *laosensis* both cardinals and laterals are like those of ordinary Unios. Here then in a group of Naiads, which at least by the shell characters appear to be closely related, we have every variation from species which occasionally have neither cardinals or laterals to those in which they are perfect.

So far as is known the animals of these different species do not greatly differ, and Lea's description of that of *Margaritana margaritifera* would almost exactly answer for that of *Unio monodontus*.

Margaritana confragosa, a species found sparingly throughout a considerable part of the Mississippi drainage basin cannot be referred, I think, to any group of Unios, but it evidently has a much closer relation to the *Asperrimus* and *Plicatus* groups than to any Margaritanas. This relation is shown in the form of the shell, which is like that of the species of both of these groups, and by its sculpture, there being two rows of tubercles radiating from the beaks after the manner of those of *Unio asperrimus*, and the body of the shell being plicate as are all the members of the Plicate group. The hinge of this species seems to have become somewhat degenerated or weakened, as it is of unusually light structure for so heavy a shell, and such teeth as appear are generally somewhat compressed. In some specimens the posterior cardinal of the left valve is recurved and cut into serrations on its edge, and fits into a somewhat open space under the beak of the right valve, something after the manner of the *Pressus* group. It will be found in occasional specimens of the *Asperrimus* group that this posterior cardinal though much heavier, is recurved and serrate on its edge, and that there is a partial corresponding break in the usually wide hinge plate of the right valve. But in a large series of *M. confragosa* almost every variation may be

found from a narrow to a heavy hinge plate, and the same is true among the Unios I have just mentioned.[1]

Margaritana holstonia and ***M. georgiana***, the latter being perhaps synonymous with the former, so closely resemble some of the Unios of the group typified by *U. nashvillensis* that Dr. Lea himself sometimes referred specimens of them to some of these species, and their only essential difference is that they are generally destitute of the lateral teeth which are present in the Unios.

Such species as *Margaritana raveneliana*, *spillmanii* and related forms have no laterals, and only partially developed cardinals. In most of the specimens the hinge line is incurved in the region of the rudimentary cardinal teeth, exactly as in the so-called *Anodonta edentula* and its allies, all of which bear close relationship to them, and I believe that they should all be placed in the genus *Unio*, since their animals, so far as is known, agree well with those of that genus.

[1] Lea's description of the soft parts of *Margaritana confragosa* agrees very closely with that of *Unio lachrymosus*, which is synonymous with *U. asperrimus*.

Unio lachrymosus Lea.

Branchiæ very large, inner ones very much the larger, rather thick, very much rounded below, free nearly the whole length of the abdominal sack.

Palpi very large, transverse, rather thin, subelliptical, united half way down the posterior edges.

Mantle rather thin, with a broad thickened margin.

Branchial opening very large, with numerous rather small, branched papillæ.

Anal opening rather small, without papillæ.

Super-anal opening very large, slightly colored on the edges, united for a small distance below, color of the mass whitish.

Margaritana confragosa Say.

Branchiæ very large, nearly semicircular, inner ones much the larger, free the whole length of the abdominal sack.

Palpi very large, pendant, sublunate, united half way down the posterior edges.

Mantle rather thin, with a thickened broad margin.

Branchial opening rather large, with numerous small, brown papillæ.

Anal opening very small, with very minute papillæ.

Super-anal opening large and united below, with a dark line on the inner edges. Color of the mass whitish.

The above are Lea's descriptions of the two species.

It would be very interesting indeed to know the exact cause of the obliteration of the teeth of these so-called Margaritanas. The teeth of the Naiads seem to be peculiarly susceptible to injurious influences, and many cases among them somewhat similar to that of the Margaritanas might be cited. In *Cristaria*, a Chinese and Japanese group, the cardinals are generally though not always obsolete, while the laterals in young or merely adult shells are developed. Old specimens are frequently without teeth, like the Anodontas, in which case they are probably absorbed in the process of growth. There is a group of peculiar Naiads found in the East Indian Archipelago, typified by *Unio bengalensis* Lea, of thin structure and lurid purplish or reddish color throughout, having a wide, internal prismatic border visible. In all of them the teeth when present are greatly compressed, and they occur in various stages from a perfect condition to almost complete obliteration, so that the species have been divided up between *Unio* and *Anodonta*. The fact that certain specimens of a given species in the group may have well developed teeth, while in others they may be almost completely wanting leads me to place all the species, which seem to form a very natural group, in *Unio*.

Pseudodon is another genus in which it is quite probable the teeth have degenerated from some cause until in most cases only a single, rounded tubercle, answering to a cardinal, remains in each valve, and one of the Chinese Naiads *Unio biasianus* is a perfect *Margaritana* with blurred laterals like *M. rugosa*, though the species probably groups with the well known *Unio sinensis*. And it is likely that *Bourguignat's* genus *Cameronia*, in which the shell is only toothed behind the beaks, is a depauperate state of *Pleiodon*, a genus in which the teeth are found throughout the entire length of the hinge plate. It is a fact that those species of Unios which seem most closely related to the Margaritanas usually have more or less imperfect laterals, and sometimes feeble or blurred cardinals.

In many localities a large proportion of the specimens of one or more species of *Unio*, especially adult or old shells, while apparently healthy in every other way show diseased hinges in which the epidermis is folded in and greatly pro-

duced, and the teeth and plate are badly injured. And the erosion of the beaks so common to Naiads in many streams usually damages the teeth.

There seem to be two forms of hinges among the so-called Margaritanas, the one like that of *M. margaritifera* and *holstonia*, in which the area occupied in the Unios by the laterals is smooth and destitute of teeth, the other like that of *M. complanata* and *calceola* in which the laterals are badly blurred and broken up as if by disease; the plate being covered with long, low, irregular ridges which run somewhat diagonally across it from the region of the beaks towards the interior of the shell. I would suggest that different causes may have operated to produce these different conditions. Dr. Dall holds, and I believe with good reason, that the teeth of bivalve shells are developed for the purpose of keeping the valves in their proper place. In such cases as they interlock it is well-nigh impossible that one valve should be twisted out of place without injuring the animal or its shell. Nearly all Unios which have strong, perfectly developed teeth live in running water, often in rapid currents, in fact it is well known that the Unios are more generally inhabitants of streams and rivers while the Anodontas, which have no teeth, live as a rule in ponds or other still waters. The different species of *Cristaria*, in which the teeth are reduced to mere rudiments, live in ponds and the ditches of rice fields, in the mud. *Unio hembelii*, with very faint laterals is found in the sluggish bayous of Louisiana. *Margaritana monodonta*, which is often nearly destitute of teeth, though living in rivers is almost invariably found under stones in mud, as is *M. hildrethiana;* both of them therefore being protected from currents. I think that the want of teeth in such forms can be explained by supposing that they have degenerated on account of their being no longer needed.

Such species as *Margaritana confragosa, rugosa, complanata* and the like, which have blurred or distorted teeth usually are found in running water, often in rapid streams, and I am inclined to believe that they are forms which are peculiarly susceptible to injurious influences, and that their teeth have become diseased on account of these influences. And it seems

to me not improbable in certain cases, where water and other elements of environment appear to be favorable for producing normal conditions of the hinge, that the fact of this part of the shell being nearly always blurred and distorted goes to show that the diseased condition has become more or less fixed and is inherited.

Be this as it may the evidence of the shells and soft parts seems to show clearly that *Margaritana* is not a valid genus, but that the name merely stands for certain groups or parts of groups of Unios of polyphyletic origin, and that all the species will have to be relegated to the genus *Unio*.

EDITOR'S TABLE.

—THE evolutionary doctrine leads us to expect that definitions of natural divisions as genera, families, orders, etc., will be ultimately rendered inapplicable through the discovery of intermediate forms. This result has, to some extent, followed paleontologic discovery. The abolition of definitions, however, can never be complete, and many will remain in accordance with the doctrine of "expression points." Evolution of characters, while gradual at bottom, ceases to be so in expression, when two or more stimuli coincide to produce something more than the arithmetical sum of the two might lead one to expect. Moreover, there are many "expressions" which only become apparent at a definite stage of development. The eruption of a tooth, for instance, is only accomplished when the line of the alveolar border is passed by the base of the crown as it rises. Yet the growth was, perhaps, uniform throughout. Especially has the "law of release" of energy probably often operated to render the immediate appearance of a structure possible, although the approach to the point of release may have been uniform and gradual. These facts are opposed to the view that systematic divisions are phylogenetic lines. The former run transverse to the latter, and are generally polyphyletic.

These remarks are apropos to the frequent carelessness exhibited by some modern writers in the use of systematic terms, family subfamily, ordinal names, etc., who use without reference to their relation to the divisions which have long borne, and must necessarily bear, those names. New names are used for divisions already named, or so nearly covered by old names that the creation of new ones is inexcusable. In the hands of some authors, almost every conspicuous genus becomes the type of a new family. Such authors are frequently at no pains to define the divisions thus proposed. The chief sinners in this direction appear to be the paleontologists and embryologists, who are sometimes unfamiliar with systematic biology. In the midst of this carelessness, it is pleasant to refer to the Catalogues of the British Museum issued of recent years. So far as regards the Vertebrata, while we cannot praise their treatment of the North American species, in their systematic work there is conservatism and conscientiousness, which is worthy of imitation everywhere.—C.

—THERE is still a lack of appreciation on the part of the benefactors of their fellow citizens of the importance of original research.

Although many facts of detail are known, few general laws are fully established, and fewer are fully understood. Before we shall grasp the laws of nature, much research will be necessary. The unexpected character of some modern discoveries furnishes ample evidence that research is the only key to knowledge, and that until our hypotheses have the support of abundant facts we must not value them too highly. An illustration of the failure of speculation to anticipate discovery, is the knowledge that various growth functions are carried on by free and wandering cells, who act as carriers of substances to and from tissues. Research in all directions in fact, meets with such reward that it should be sustained by all persons who desire to encourage the progress of knowledge. But the rich men of our country do not discriminate between this function or that of teaching. They found Universities with praiseworthy and princely liberality, but research has to struggle with poverty of means and deficiency of time. Great libraries are founded, but the work in the laboratory from which issue the books which create libraries, receives comparatively little substantial encouragement. It is also the fact that the general public does not discriminate between the distributor and the producer of knowledge The compiler is often mistaken for the discoverer. The education offered in our Universities will correct this in many minds, and then later other facts will have to be understood. This is, that the mental peculiarity which belongs to the discoverer, is not a general one. Every naturalist of long experience will recall the numbers of men who have entered this field to leave it. Men who take a course in a foreign University and write an original thesis for a degree, frequently never make another contribution to science. These are not the men to endow as original investigators. The combination of good sense-perception with memory and systematic skill, along with perseverance and the comprehension of ways and means, with an idealism which justifies the end in view, is not very common ; and presumably, when present, is often suppressed by adverse circumstances of life. Initiative and discovery are the condition of progress, and no better service could be rendered to humanity than the creation of opportunities for their activity.

One of the principal fields of future discovery is the Antarctic continent. No one has approached nearer to the South Pole than 65° S. so that the unexplored region is at its narrowest point greater in width than the continent of North America. While the possibilities of botanical and zoological discovery in such a region, under the rigorous

climatic conditions that prevail there, is less than on any equal area of the earth's surface, they must be nevertheless considerable. But the immense additions which will accrue to geology and the climatic history of the earth in past ages cannot be overestimated, and the probability of important additions to our knowledge of ancient life is great. It is to be hoped that the projects now on foot in this country and elsewhere for Antarctic exploration will be sustained in such a way as to insure their success. An Antarctic expedition should be furnished with every facility for collecting on land and sea, including apparatus for deep sea dredging.

In his account of the Cold Spring Harbor Laboratory, published in the last number of the Naturalist, Professor Conn seems to mistake the field and purpose of the Marine Biological Laboratory at Wood's Holl. From the first, instruction has been encouraged as much as investigation, and in any year the number of students receiving instruction will far exceed those carrying on independent research. The Marine Biological Laboratory is for the diffusion as well as for the increase of knowledge, and the fact that it trains many of those who come to it for elementary instruction, to become, eventually, investigators, does not in the least invalidate its claim to be considered an institution for instruction.

In the editorial columns of the *Philadelphia Evening Bulletin*, of March 21st, appeared a quotation of remarks made by the Secretary of the Academy of Natural Sciences with reference to the Peary Relief Expedition. These remarks are to the effect that the Academy will not subscribe to the expedition which is to start shortly to bring Lieutenant Peary back from the Arctic regions; and the reason given is that the results obtained by the Peary Expeditions are not of sufficient scientific importance to warrant the Academy in making the subscription. As this is the second time within the last few months that persons in authority in that institution have expressed such sentiments regarding the Peary Expeditions, there is probably some truth in the statement that the Academy will not subscribe to this enterprise. It is to be hoped, however, that the real reason for this action is financial inability, rather than that which has been given by these self-constituted mouthpieces of the Academy. It should not be necessary to repeat, at this day the importance of such expeditions to science. There is no doubt that if the Academy can stand this kind of talk, Lieutenant Peary can-

RECENT LITERATURE.

Botany in the Secondary Schools.[1]—We have before us a most excellent guide to plant study, bearing the marks of faithful, conscientious effort from title page to finish. No one who has had experience in conducting courses in botany with college students will deny that a great deal of the instruction given in this science in secondary schools is loose, unscientific and crude to the last degree. Notwithstanding the recent attention given to this fact in scientific journals the evils have not yet by any means been entirely remedied. Indeed they frequently extend beyond the lower schools, even into the colleges and universities themselves.

The author of this Guide is well-known as a thoroughly successful botanical teacher of many years experience, and all the statements which he makes have been subjected to practical laboratory tests. Two things are to be especially guarded against in a manual of this kind: Telling the student too much, and giving too meagre assistance. In the latter case, either discouragement results or undue attention is paid to minor points while important matters are either entirely overlooked, or studied without reference to their proportionate significance. Some teachers in their eagerness to avoid the first blunder fall into the second which is even worse. Professor Spalding has, in most cases, satisfactorily avoided both errors.

The introduction contains timely suggestions to students and teachers, together with a well selected list of books of reference and laboratory material. We wish, however, to take emphatic exception to the statement that "in every case the pupil is to be provided with the material used." One of the principal objects in the study of any natural science should be to encourage the student to become acquainted with nature in its broadest sense, a knowledge to be obtained only by personal exploration in woods and fields. As has been previously pointed out in various journals the modern tendency of scientific study is to lose sight of the naturalist in the almost exclusive attention given to laboratory work. The benefit to be gained from the study of a flower or plant brought by the teacher to his classes is one-sided and very incomplete, and should by all means be supplemented by the personal investiga-

[1] Guide to the Study of Common Plants, an Introduction to Botany. Volney M. Spalding, Professor of Botany in the University of Michigan. Second edition, xxiii, 294 pp. Published by D. C. Heath & Co., Boston, 90 cents, postpaid.

tions of the students in its native habitat. As a matter of fact, however, the author does not adhere strictly to the advice above given but generally takes it for granted that the plant has also been observed while growing.

Chapters are given on seeds, germination, the root, stem, leaf, flower and fruit. Then the so-called flowerless plants are taken up, and the sea weeds and their allies, molds and rusts, mosses and liverworts, ferns and horsetails are studied. The conifers and leading families of monocotyledons and dicotyledons follow in their natural order.

Each chapter begins with a list of material needed for study, contains minute and practical directions to the student and closes with an admirable summary. Copious references to the literature of the subjects are given in foot notes. One of the most valuable features of the work are the numerous questions asked and the special topics for study which the author suggests under each group. Simple physiological experiments, such as any student working alone, or teacher even in our district schools can easily perform, are described. Such subjects as seed dispersion and protection, fertilization, assimilation, respiration, and transpiration, adaptation of various plant organs to their environment as well as plant relationships are treated in a fresh and interesting manner quite different from the ordinary laboratory guides.

When one considers the great diversity and looseness of terminology employed by many prominent botanical writers, the difficulty as well as the necessity is apparent of having accurate definitions and plant descriptions. The glossary at the close of Professor Spalding's Guide is most commendable, and constitutes one of the many admirable characters of work which we heartily commend to all lovers of plant life. Not only secondary schools, but also students working by themselves will find it exceedingly helpful. We know of nothing better adapted to the short winter courses given by some of our Agricultural Colleges, and for use in University Extension instruction.

GILBERT H. HICKS.

The New Check-List of Plants.[2]—The recent considerable changes in botanical nomenclature have made necessary such a book as the one here noticed. We have had in various monographs and scattered notes in botanical journals so many records of changes, and notices of others which should be made, that any one doing critical work has been compelled to make a catalogue for himself, or lose much time whenever he worked over a new lot of species. One does not have to subscribe to everything done by the committee to feel that the

work will be a useful one. Take a couple of cases from Papaveraceæ; all remember something of the discussion as to the proper generic name for the "Dutchman's Breeches," given in our manuals as *Dicentra*. Here we find that *Dicentra* was proposed by Bernhardi in 1833, and that he was anticipated by Borckhausen who published the name *Dielytra* in 1797, but who was himself preceded by Adanson who in 1763 first used the name *Bikukulla*, which in its corrected from *Bicuculla* is, therefore, the name we should cite in this instance.

Again we have the genus *Corydalis* in our manuals; but if we look up its history we find that this name was proposed by Ventenat in 1803; but Scopoli's name *Neckeria* precedes this by more than a quarter of a century (1777), while Adanson's name *Capnoides* is earlier still (1763).

We are becoming so democratic, even in science, that it is desirable that the reasons for changes and modifications should be laid before the public. Even the most obscure botanist is nowadays entitled to know why an old plant comes out under a new name. It may vulgarize science somewhat and take from it that element of the mysterious which it formerly possessed, if we lay these things before the world. When the world learns that the pronouncements of "Science" are after all only the judgments of, say, Professor Britton, Professor Coulter, Professor Scribner, or some other mortal, it may not stand in such ignorant, open-mouthed wonder as it formerly was wont to do. It may even cry out against them, and demand that the golden calf be set up again. But if these professors set forth plainly that their work is plain work, the plain and straightforward statement of facts, the world will eventually cease to be the blind idolaters of that which they do not understand.

This book is quite likely to be railed at by some people who are themselves botanists. In one respect it is a revolutionary work, or rather, it is the mark of a revolution, and in all revolutions there are some who fear the consequences. This book is the sign that the day of "authority" as such, is ended, and the day of "law" has begun. The day of botanical "equality before the law" has come, and the humblest botanist now may lawfully correct the greatest.

What, now, is this work? It includes the names of about 4350 species, each of which has been critically examined, and as far as pos-

[2] List of Pteridophyta and Spermatophyta growing without cultivation in Northeastern North America. Prepared by a committee of the Botanical Club, American Association for the Advancement of Science, 1893--1894. Price $3.00 (Memoirs of the Torrey Botanical Club, Vol. V.)

sible, its synonymy adjusted in accordance with the Paris Code of 1867, as interpreted by the botanists at Rochester in 1892 ("Rochester Rules"). Thus the point of beginning for generic and specific names is 1753, the date of the first edition of the *Species Plantarum* of Linnæus, and in all cases "priority of publication" has been regarded as of prime importance in the determination of the name to be employed. Thus we have here given that name for each plant which these botanical laws indicate, and in the list of synonyms we find the names which these same laws compel us to reject. The treatment may be better understood by a couple of examples, as follows:

1953. **Cleome serrulata** Pursh, Fl. Am. Sept. 441 (1814).
Cleoma integrifolia T. & G., Fl. N. A. I: 122 (1838).

4303. **Taraxacum taraxacum** (L.). Karst. Deutsch. Fl. 1138 (1880–'83).
Leontodon taraxacum L., Sp. Pl. 798 (1753).
Taraxacum officinale Weber., Prim. Fl. Holst. 56 (1780).
Taraxacum dens-leonis Desf., Fl. Atlant. 2: 228 (1800).

What more could be asked? The whole history of the species is here given so plainly that any one may verify each step for himself. That the work will be found to contain errors and omissions goes without saying. The committee did not expect to present a faultless work, but they did set before themselves the task of making an honest, plain list in which they record their findings, and for this the botanists of all sects and schools, in all parts of the world owe them a deep debt of gratitude.

CHARLES E. BESSEY.

Bulletin of the U. S. Fish Commission Vol. XII.[3]—This quarto volume contains eleven important papers on fishes of the United States, prepared by specialists, together with a report on the Oyster Industry of Maryland, by C. H. Stevenson. Much of the information imparted in these papers is new, and valuable either from an economic, or a purely scientific standpoint. All are splendidly illustrated with page plates, making in all 118 plates accompanying the text. The following table of contents shows the range of subjects treated.

Bean, T. H. Bibliography of the Salmon of Alaska and adjacent Regions.—Life History of the Salmon.—Eigenmann, C. H. On the

[3] Bulletin of the United States Fish Commission. Vol. XII for 1892. Washington, 1894.

Viviparous Fishes of the Pacific Coast of North America.—Evermann, B. W. Description of New Sucker (*Pantosteus jordanii*) from the Upper Missouri Basin.—Evermann, B. W. and W. C. Kendall; The Fishes of Texas and the Rio Grande Basin, considered with reference to their Geographic Distribution.—McDonald, M. Report on the Salmon Fisheries of Alaska.—Moore, H. F. List of Fishes collected at Sea Isle City during the Summer for 1892.—Rathbun, R. Summary of Fishery Investigations conducted in the North Pacific Ocean and Behring Sea from July 1, 1888 to July 1, 1892, by the U. S. Fish Commission Steamer *Albatross*.—Smith, H. M. The Fyke Nets and Fyke-Net Fisheries of the United States, with Notes on the Fyke Nets of Other Countries.—Economic and Natural-History Notes on Fishes of the Northern Coast of New Jersey.—Stevenson, C. H. The Oyster Industry of Maryland.—Ulrey, A. B. and C. H. Eigenmann; A Review of the Embiotocidæ.

Paleontology of Missouri, Part I.[1]—This memoir is a concise account of the fossil invertebrate fauna of Missouri prepared by the State Geologist, C. R. Keyes with reference to the distinct economic importance that organic remains have in determining the age of rocks and hence aiding to develop the mineral wealth of the state. Following the introductory chapter is a brief sketch of the stratigraphy of the state and an explanation of the biological relations of fossils. The remaining pages are devoted to descriptions of the invertebrate fossils of the state which have passed under the personal observation of the author.

For illustration the leading Missouri species of each genus has been figured, and also some forms heretofore described but not figured, making in all 20 plates. In addition many typical exposures of rocks are well represented.

[1] Missouri Geological Survey Vol. IV. Paleontology of Missouri, Part I. By Charles R. Keyes.

RECENT BOOKS AND PAMPHLETS.

Agriculture of Pennsylvania. Containing Reports for 1893 of the State Board of Agric., State Agric. Soc., State Dairyman's Assoc., State Horticul. Soc., and the State College. From Thos. J. Edge.

Annual Reports of the Academy of Natural Sciences of Philadelphia for 1893.

Annual Report of the Arkansas Geological Survey, Vol. II, 1894.

Annual Report of the Yorkshire Society for 1893.

BAILEY, L. H.—A Paper on Electricity and Plant-Growing. Extr. Trans. Mass. Horticul. Soc., 1894.

BARBER, H. G.—A List of Nebraska Butterflies. Extr. Proceeds. Nebr. Acad. Sci., IV, 1894. From the author.

BARBOUR, E. H.—Additional Notes on the New Fossil, Dæmonelix. Its Mode of Occurrence, Its Gross and Minute Structure. Extr. Univ. Studies, Vol. II, 1894. From the author.

BEAN, T. H.—The Fossils of Pennsylvania. Harrisburg, 1893. From the author.

BEECHER, C. E.—On the mode of occurrence, and the structure and development of *Triarthrus becki*. Extr. Am. Geol., 1894.——The Appendages of the Pygidum of Triarthrus. Extr. Am. Journ. Sci., Vol. XLVII, 1894. From the author.

Biennial Report of the Alabama Bryce Insane Hospital for 1893 and 1894.

Book of the Tariff as prepared by the U. S. Senate of 1893–94.

Bulletin of the United States Fish Commission, Vol. XII, for 1892. Washington, 1894.

BUTLER, A. W.—The range of the Crossbill in the Ohio Valley, with notes on their unusual occurrence in Summer. Extr. Proceeds. Brookville Academy, 1892. From the author.

CHENEY, E. P.—Translations and Reprints from Original Sources of European History. The Early Reformation Period in England. Wolsey, Henry VIII, and Sir Thomas More. Philadelphia, 1894. From the author.

DAWSON, G. M.—The Progress and Trend of Scientific Investigation in Canada. Extr. Trans. Roy. Soc. Canada, 1894. From the author.

EIGENMANN, C. H.—Results of Explorations in Western Canada and the Northwestern United States. Extr. Bull. U. S. Fish Commission for 1894. From the author.

EYERMAN, J.—On a Collection of Tertiary Mammals from southern France and Italy, with brief descriptions thereof. Extr. Am. Geol., Vol. XII, 1893. From the author.

Geological Map of Alabama, with Explanatory Chart. Montgomery, 1894. From Eugene A. Smith.

HOBBS W. H.—On a Recent Diamond Find in Wisconsin, and on the probable Source of this and other Wisconsin Diamonds. Extr. Amer. Geol., Vol. XIV, 1894. From the author.

HOLMES, W. H.—An Ancient Quarry in Indian Territory. Published by the Bureau Ethnology of the Smithsonian Institution, 1894. From the Smithsonian Institution.

HORN, G. H.—The Coleoptera of Baja, California. Extr. Proceeds. Cal. Acad. Sci., Vol. IV, 1894. From the author.

JUNGERSEN, H. F. E.—Die Embryonalniere von *Amia calva*. Separat-Abdruck aus dem Zool. Anz., 1894. From the author.

KEYSER, L. S.—In Bird-Land. Chicago, 1894. From the Pub., A. C. McClurg & Co.

KEYES, C. R.—Paleontology of Missouri (Part I). Missouri Geol. Surv. Vol. IV, 1894. From the author.

LAMBORN, R. H.—Some Italian "Survivals."—A "Longhouse" in the Tiber Delta. Extr. Science, March, 1894. From the author.

LAWSON, A. G.—The Geomorphegeny of the Coast of Northern California. Extr. Bull. Univ. Cal., Vol. I, 1894. From the University.

MASON, O. T—Woman's Share in Primitive Culture. New York, 1894. From the author.

MILLER, G. S.—On a collection of small Mammals from the New Hampshire Mountains. Extr. Proceeds. Bost. Soc. Nat. Hist., Vol. XXVI, 1894. From the author.

MURRAY, AARON E.—The Butterfly Hunters in the Caribbees. New York, 1894. From the Pub., Charles Scribner's Sons.

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RYDER, J. A.—Dynamical Evolution. A Lecture delivered at the Marine Laboratory at Woods Holl. Boston, 1894. From the author.

SALMON, D. E.—Investigations Concerning Bovine Tuberculosis, with Special Reference to Diagnosis and Prevention. Bull. No. 7, 1894, U. S. Dept. Agric., Bureau Animal Industry.

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SEELEY, H. G.—On *Euskelesaurus brownii* Huxley. Extr. Am. Mag. Nat. Hist., Vol. XIV, 1894. From the author.

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SPENCER, J. W.—The Duration of Niagara Falls. Extr. Am. Journ. Sci., Vol. XLVIII, 1894.

Review of McGee's Lafayette Formation. Twelfth Ann. Rept. U. S. Geol. Surv. From the author.

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VARIGNY, H. DE.—Recherches sur le Nauism Experimental. Contributions à l' étude de l' influence du milieu sur les organismes. Extr. Journ. L'Anatomie et de la Physiologie, 1894. From the author.

WALCOTT, C. D.—Note on some Appendages of the Trilobites. Extr. Proceeds. Biol. Soc. Washington, 1894. From the author.

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WINSLOW, A.—The Coal Measures of Missouri. Extr. Min. Resources U. S., 1892. Washington, 1893.——Geological Surveys in Missouri.——Notes on the Lead and Zinc Deposits of the Mississippi Valley and the Origin of the Ores. Extr. Journ. Geol. No date given. From the author.

General Notes.

GEOGRAPHY AND TRAVELS.

Where is the greatest forest in the world ?—The question was asked in the Forestry section of the American Association for the Advancement of Science, at its last annual meeting. The importance of forests for equalizing the climate and the rainfall of the globe was under discussion, and the purpose of the question was to show where the great forest tracts of the world are situated.

One member replying off hand, was inclined to maintain that the greatest continuous tract of forest lies north of the St. Lawrence River, in the provinces of Quebec and Ontario, extending northward to Hudson Bay and Labrador; a region measuring about 1,700 miles in length from east to west, and 1,000 miles in width north and south.

A professor from the Smithsonian Institution rejoined that a much larger continuous area of timber lands was to be found, reckoning from those in the State of Washington northward through British Columbia and Alaska. But he limited his statement to North America, for he added that, in his opinion, the largest forest in the world occupied the valley of the Amazon, embracing much of northern Brazil, eastern Peru, Bolivia, Ecuador, Colombia, and Guiana; a region at least 2,100 miles in length by 1,300 in breadth.

Exception was immediately taken to this statement by several members who, in the light of recent explorations, have computed the forest area of Central Africa in the valley of the Congo, including the head waters of the Nile to the northeast, and those of Zambesi on the south. According to their estimates, Central Africa contains a forest region not less than 3,000 miles in length from north to south, and of vast, although not fully known width, from east to west. Discussion, in which the evidence afforded by travels and surveys was freely cited, seemed favorable to the defender of the Amazonian forests.

Later in the day the entire question was placed in another light by a member who was so fortunate as to be able to speak from some knowledge of still another great forest region of the globe. This gentleman gave a vivid picture of the vast, solemn taigas and urmans, the pine, larch and cedar forests of Siberia.

It appears that Siberia, from the plain of the Obi River on the west to the valley of the Indighirka on the east, embracing the great plains,

or river valleys, of the Yenisei, Olenek, Lena and Yana rivers, is one great timber belt, averaging more than 1,000 miles in breadth from north to south—being fully 1,700 miles wide in the Yenisei district—and having a length from east to west of not less than 4,600 versts, about 3,000 miles. Unlike equatorial forests, the trees of the Siberian taigas are mainly conifers, comprising pines of several varieties, firs and larches. In the Yenisei, Lena and Olensk regions there are thousands of square miles where no human being has ever been. The long-stemmed conifers rise to a height of 150 feet or more and stand so closely together that walking among them is difficult.

The dense, lofty tops exclude the pale Arctic sunshine, and the straight, pale trunks, all looking exactly alike, so bewild e
the obscurity that all sense of direction is lost. Even the most experienced trappers of sable dare not venture into the dense taigas without taking the precaution of "blazing" the trees constantly with hatchets as they walk forward. If lost there the hunter rarely finds his way out, but perishes miserably from starvation or cold. The natives avoid the taigas, and have a name for them which signifies "places where the mind is lost."

The discussion closed very appropriately by Prof. Fernow, of Washington, with an illustrated lecture, which showed how in the earlier ages forests had covered all the continental areas, and had rendered the climate equable to a degree now unknown.

At first human beings battled with the forest in a fitful manner, making small clearings for themselves; but, gradually, by the aid of fire, and of their own increasing numbers, they have so far prevailed in the struggle for supremacy that the forests are hopelessly conquered. But grave evils follow their extermination; and now the question is how to foster, protect and preserve them. (Quoted from Youth's Companion, Scientific American, March, 1895.)

MINERALOGY.[1]

Symmetry of Nepheline and Davyne.—Baumhauer's studies of the etched figures of nepheline produced by hydrofluoric and hydrochloric acids, have shown that the mineral belongs in that division of the hexagonal system in which trapezohedral or pyramidal hemihedrism is combined with hemimorphism—the first hemimorphic tetartohedrism of Liebisch—and that apparently simple individuals are usually compound twins, the twinning planes being the base and the second order prism. As more recent studies of Tenne seemed to lead to a different conclusion, Traube[2] has repeated Baumhauer's studies on excellent material from Vesuvius, with the result of confirming the latter in every particular. He has also obtained excellent figures on the prism planes by use of concentrated or warm dilute hydrochloric acid, the figures having the same symmetry but not the same form as those produced by hydrofluoric acid. He has observed one twinning law in addition to the two described by Baumhauer. The examination of a twinned section 5 mm. in thickness cut normal to the principal axis gave no evidence of circular polarization. He has investigated for the first time the etched figures of the closely related mineral Davyne, which may be easily etched with nitric acid. On the prism planes these figures possess two lines of symmetry, normal to one another, showing that the mineral is holohedral hexagonal. As nepheline is not attacked by nitric acid this affords a ready means of distinguishing the two minerals from one another. It is especially valuable because Traube finds that Davyne is not always optically positive as has been supposed.

The Minerals of the Emery Deposits of Naxos.—Except for a paper by Smith on the paragenesis of these deposits and one by Zirkel on the two chief minerals (corundum and magnetite), no scientific mineralogical study of the deposits has heretofore been made. Tschermak[3] contributes to the *Mittheilungen* the results of a detailed study of a large number of specimens from the locality. The island of Naxos is composed of fine grained gneisses and marbles resting on a basement of coarse grained gneisses. The emery occurs in numerous

[1] Edited by Dr. Wm. H. Hobbs, University of Wisconsin, Madison, Wis.

[2] Neues Jahrb. f. Min. etc., Beil. Bd. ix, pp. 466–479, 1894.

[3] Min. u. petrog. Mittheil., xiv, pp. 311–342, 1894.

lenticular masses of great extent and having a thickness of 5 to 50 meters, enclosed in the granular limestone. It is chiefly a mixture of corundum and magnetite with hematite and limonite as alteration products. The only accessory mineral usually apparent to the naked eye is margarite, but Tschermak shows that there are often present in small quantities both the common micas, chlorotoid, Vesuvianite, diaspore, kyanite, staurolite, rutile, spinel, and pyrite. Thin sections were prepared and detailed descriptions are furnished of the optical properties of the different constituents. The corundum is part crystallized and part in grains. The crystals show zonal distribution of the pigment and optical anomalies, and are frequently filled with magnetite and rutile inclusions. The margarite yields in lath-shaped sections a positive bisetrix with axial plane normal to the cleavage. Basal sections afford a negative bisectrix with small optical angle. The double refraction is lower than that of muscovite. The structure of the emery is quite schistose, due chiefly to the distribution of the magnetite grains which form layers of variable thickness. Tschermak thinks that the original condition was a compact and homogeneous mass, and that the accessory minerals were separated out when the corundum and magnetite were crystallized. Analyses of the emery from Kremnó and Renidi were made by Ludwig with the following results:

Kremnó.

SiO_2 5.64, B_2O_3 1.15, Al_2O_3 57.67, Fe_2O_3 33.36, MgO 0.83, CaO 0.43, K_2O 0.31, Loss on ignition, 0.70, Total 100.09.

Renidi.

SiO_2 5.45, B_2O_3 0.88, Al_2O_3 56.52, Fe_2O_3 34.65, MgO 0.43, CaO 0.90, Na_2O 0.60, K_2O 0.40, Loss on ignition 0.42, Total 100.25.

A lengthy detailed description of specimens of emery from the different localities closes the paper.

Boleite and Cumengeite.—In a separate publication Cumenge[4] has given a more complete description than has heretofore been made of the interesting minerals Boleite and Cumengeite, which were recently found in the copper mining district of Boleo in Lower California. *Boleite* occurs in apparently cubic crystals of a deep indigo blue color in an argillaceous gangue locally known as *Jaboncillo*. They

[4] Note sur deux espèces minérales nouvelles la Boléite et la Cumengéite, par M. E. Cumenge, Paris, 1893.

fuse readily in a candle flame, have a hardness of 3, and a specific gravity of 5.08. The index of refraction is very high, approximately 2.07. The composition of the mineral is expressed in the formula $PbCl_2+CuOH_2O+\frac{1}{3}AgCl$ or as it was written by Mallard, 3 { PCbl (HO). CuCl(HO) { +AgCl. The crystals are apparently cubes which are sometimes truncated by the octahedron or the dodecahedron. Cleavage is perfect parallel to (100) and less perfect parallel to (111). The optical properties show clearly that the apparent cubic form is caused by the twinning of three tetragonal individuals so that their axes are all normal to one another.

Cumengeite is much like Boleite but occurs in pyramidal crystals, is more violet in tone, and has hardness and specific gravity somewhat inferior to those of Boleite. Chemically it differs from that mineral in the absence of $\frac{1}{3}AgCl$, the formula being given as PbC2 (Index) $+CuOH_2O$. The symmetry is tetragonal, the crystals being usually bounded by á (011) and m (110) and rarely also by p (001). In connection with the simple individuals of Boleite and Cumengeite are found very interesting twinned individuals which usually give the appearance which would result from attaching by its square face to each of the six faces of a cube the half of a symmetrically developed octahedron. The face of this particular pyramid (*l*) has not been observed on any of the individuals of either mineral. Sometimes the solid angles of the projecting pyramids formed by *l* are symmetrically truncated, so that an apparent cube with reentrant or grooved edges is the result. The composition of these interesting trillings has not been fully determined, but they are found to be intermediate between Boleite and Cumengeite in their content of silver. Mallard has applied to them the name Percylite which had before been used for an undetermined cubic mineral of somewhat allied characters. Friedel has succeeded in producing artificial crystals of both Boleite aud Cumengeite by the action of copper chloride on lead hydrate.

The Formula of Pseudobrookite.—The chemical composition of pseudobrookite has been determined by Cedarström on material from Havredal in Norway and by Rimbach on selected material from the Aranyerberg in Siebenbürgen, to be represented by the formula $2Fe_2O_3\ 3TiO_2$, the two analyses agreeing very closely. The analysis of an artificial pseudobrookite from Schönebeck on the Elbe yielded Doss the formula $Fe_2O_3\ TiO_2$, and led the analyst to suppose that the mineral is isomorphous with andalusite. Frenzel[5] has undertaken an analysis of the material from the Aranyerberg and obtained results

[5] Min. u. petrog. Mittheil., xiv, pp. 126–130, 1894.

which agree perfectly with those of Cedarström and Rimbach. Traube has contributed to the same paper the almost identical results of an analysis of the same material, so that there can be little doubt that $2Fe_2O_3\ 3TiO_2$ is the correct formula of the mineral. Frenzel points out the absurdity of the supposed isomorphous relation with andalusite. Neglecting the earlier analyses by Koch and by Lattermann on imperfectly purified material, the analyses that have been made of pseudobrookite are as follows:

	I	II	III	IV	V	VI
TiO_2	44.26	42.49	33.59	42.89	42.35	42.896
Fe_2O_3	56.42	58.20	66.42	56.37	57.65	57.104
Total	100.68	100.69	100.01	99.26	100.00	100.000

I. Cedarström, II. Rimbach, III. Doss, IV. Frenzel, V. Traube, VI. theory from formula $2Fe_2O_3\ 3TiO_2$.

Formula of Staurolite.—Rammelsberg[6] takes exception to the formula for staurolite recently proposed by Penfield[7] ($HAl_5Fe\ Si_2O_{13}$). He claims that the analyses of staurolite show the mineral to represent chemically three varieties, as follows:— A, where $\overset{II}{R} : R_2 = 1 : 2$; B, where $\overset{II}{R} : R_2 = 1 : 2.5$; and C, where $\overset{II}{R} : R_2 = 1 : 3$. Penfield's formula, he states, is not a general one because it only represents the analyses which fall in group B.

[6] Neues Jahrb. f. Mineral., etc. Beil. Bd., ix, pp. 480–484, 1894.

[7] Am. Jour. Sci., (3) xlvii, pp. 81–89, 1894.

Wm. H. Hobbs.

PETROGRAPHY.[1]

Some Basalts of Asia Minor.—The rocks near Kula, Asia Minor, are basalts in sheets and lava streams, the latter emanating from a number of old volcanic centers whose cores may still be distinguished. These basalts, according to Washington,[2] are hornblende-plagioclase basalts, characterized especially by the abundance of their hornblendic component. This mineral, augite and olivine are present as phenocrysts in a groundmass made up of plagioclase, magnetite and glass, the latter being lighter in color as the magnetite in it increases in quantity, thus indicating that this mineral was one of the latest separations from the magma. Leucite was discovered in two of the streams. It presents no unusual features. The mineral is rare in hornblendic basalts elsewhere. None of the components of the rocks merit special mention but the hornblende. This is always porphyritic and is present in large quantity. Its color is yellow, brown or greenish-yellow, and its extinction varies from 4° to 23°. The chemical alterations effected in the mineral by magmatic resorption are interesting. One effect is the replacement of the hornblende by a reddish-brown mineral associated with colorless augite and opacite, and another is its partial or complete alteration into augite and opacite. The brown mineral is referred to hypersthene, although the analysis of a portion of the rock containing a large quantity of it was rather against this theory. The author thinks that the formation of the mineral was probably due to the reducing action of hydrogen (from dissociated water included in the lava) upon the ferric iron of the hornblende. In structure the basalts are normal, hyalopilitic, semi-vitreous and tachylitic. An analysis of a leucite variety gave:

SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	P_2O_5	H_2O	Total
47.74	20.95	3.29	6.32	7.56	5.16	7.12	1.21	.13	.04	= 99.52

Since the hornblende is of primary importance in the basalts of Kula, it is proposed to call them, and other basalts in which hornblende predominates over augite and olivine, by the name of Kulaites.

The Igneous Rocks of the Eureka District.—In an appendix to the Geology of the Eureka District, Iddings[3] gives an account of

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Maine.

[2] Amer. Jour. Sci., Feb., 1894, p. 114.

[3] Monograph XX U. S. Geol. Survey, p. 337.

the igneous rocks of the region with special reference to the lavas whose studies led Hague to the proposal of the theory that the various types of rocks in the Eureka district are differentiated portions of one magma, which split up into two, one yielding feldspathic acid rocks and the other pyroxene basic ones. Among the intrusive rocks of the region Iddings mentions only granites, granite-porphyries and quartz-porphyries. The volcanic rocks include hornblende-andesite, hornblende-mica-andesite, dacite and rhyolite, which are the types derived from the more acid portion of the original magma, and pyroxene-andesites and basalts derived from the basic portion. The pyroxene-andesite contains anorthite, hypersthene, augite, hornblende, a little biotite and an occasional quartz grain, in a glassy groundmass with a felt-like structure produced by labradorite and augite-microlites. The hornblende-mica-andesites are more acid. They contain labradorite, hornblende, biotite and a little quartz as porphyritic crystals in a micro-crystalline groundmass of lath-shaped plagioclases and intergrowths of feldspar and quartz. The dacites are rare. They possess macroscopic quartz-phenocrysts together with hornblende, hypersthene, a little augite, biotite, labradorite, anorthite, and possibly orthoclase in a pumiceous glass base, which also often contains many beautifully crystallized zircons. The rhyolites met with present few characters of special interest. They vary in the texture of their groundmass from micro-crystalline to glassy varieties. Their sanidine phenocrysts have the plane of their optical axes sometimes in the plane of symmetry and sometimes perpendicular thereto. Occasionally the rock possesses also phenocrysts of hypersthene. The basalts are poor in olivine, and this mineral when present is often changed into serpentine or into the reddish-brown substance to which Lawson has given the name iddingsite. Hypersthene is present in some of the sections, and in others are a few grains of quartz surrounded by augite borders.

Notes from Minnesota.—In a preliminary report of a season's field work in northeastern Minnesota, Elftman[1] refers to the gabbro of the region as producing contact metamorphism in the slates and schists to the north of it. He describes more particularly the actinolite-magnetite slates, from near Birch Lake, that are believed to have originated in a fragmental rock whose nature, however, is not fully set forth. The gabbro is an olivinitic variety. In it are great masses of anorthosite regarded by the author as phases of the gabbro. This is the rock

[1] 22d Ann. Rep. Geol. & Nat. Hist. Survey of Minn., p. 141.

which was reported by Lawson[5] as representing an old basement lying unconformable beneath the gabbro.

The Geology of Dartmoor, England.—McMahon[6] gives a few brief descriptive notes on some trachytes, felsites, mica-diorites, dolerites, tuffs and hornblende-schists from the western flank of Dartmoor. The trachytes and felsites are more or less altered, and the tuffs always very much so. The tuffs contain fragments of several kinds of lavas and of altered sedimentary rocks. The cementing material is "like the microgranular base of some rhyolites and porphyries." The most interesting rocks are the hornblende schists, which are thought by the author to be altered basic tuffs. They are marked by a fine grained parallelism of their constituents, producing a structure which the author designates the "corduroy structure." The rocks consist of augite, secondary hornblende and feldspar, the first two of which are often well crystallized. Their alteration is thought to be due to the intrusion of the tuffs by the great mass of epidiorite of the Cock's Tor. The basic schists of the Lizards that have been so repeatedly discussed, are believed to have had a similar origin.

Miscellaneous Notes.—The study of a series of nepheline rocks leads Gentil[7] to the conclusion that the peg structure so characteristic of this mineral is an effect of alteration. The alteration product is often a hydrated pleochroic substance with a yellowish tinge. The 'pegs' are produced by the extension of this substance along directions of feeble cohension in the original mineral (solution planes?)

The rock by whose decomposition the apophyllite[8] of Callo in Algeria was formed, is a biotite-augite-andesite, whose groundmass is usually more altered than the phenocrysts. The inclusions found in the rock are of cordierite gneiss, fragments of andalusite and of sillimanite and large segregations of plagioclase a little more basic than the feldspar of the phenocrysts.

On account of the similarity in crystalline structure between flint and Arkansas whetstone, Rutley[9] is inclined to regard the latter rock as derived by the replacement of limestone or dolomite by silica. The rhombohedral cavities noted by Griswold are thought to have been

[5] Bull. No. 8, Geol. & Nat. Hist. Survey of Minn.
[6] Quart. Jour. Geol. Soc., 1894, p. 338.
[7] Bull. Soc. Franc. d. Min., xvii, p. 108.
[8] Ib., p. 11.
[9] Quart. Jour. Geol. Soc., 1894, p. 377.

produced by the solution of some crystals of calcite or dolomite that remained for a time in the midst of the replacing silica after all the rest of the carbonate had been removed.

Pearce[10] gives a series of analyses to sustain his theory that the free gold of the Cripple Creek District, Colorado, has been mainly derived from the oxidation of tellurides.

In a preliminary report on the Rainy Lake Gold Region in Minnesota and Manitoba, H. V. Winchell and U. S. Grant[11] give some brief notes descriptive of the Laurentian, Coutchiching and Keewatin rocks of the district.

[10] Colo. Scient. Soc., April 5, 1894.

[11] 23d Geol. & Nat. Hist. Sur. of Minn., p. 36.

GEOLOGY AND PALEONTOLOGY.

Origin of the Continental Area of Australia.—The following account of the probable origin of the Australian Continent is given by Professor David in a presidential address before the Linnean Society of New South Wales:

"That the movements of the earth's crust which laid the foundations of the Australian Continent commenced in Pre-Cambrian time is conclusively proved by the vast amount of folding to which the Archean rocks at Androssan and in the Mount Macdonnell Ranges were subjected before the deposition of the earliest Cambrian sediments.

"In Tasmania the crumpling of the crust took place between E. N. E. and W. S. W. directions, so that the axes of the fold trend N. N. W. and S. S. E.

"At St. Vincent's Gulf, near Adelaide, the folds run chiefly N. E. and S. W., and N. N. E. and S. S. W., so as to meet, if produced, a prolongation of the Tasmanian axes toward the N. W., nearly at right angles. In the Macdonnell and Musgrave Ranges, the trend is E. and W., and in the Kimberly District of West Australia, N. W. and S. E., with a secondary folding S. W. and N. E.

"It is not certain whether, either in Australia or Tasmania, there was any land surface in Archean time, but the conglomerates in the Archean and in the succeeding Cambrian, and the ripple-marked flaggy quartzites (if they are Archean or Cambrian and not Lower Silurian) imply shallow seas, with probably a neighboring land surface. It is improbable, too, that the Archean strata should have been as powerfully folded, as observation shows them to have been, in Pre-Cambrian time, without some areas being elevated sufficiently to form land.

"In Australia, therefore, there was probably land and probably contemporaneous life, at all events, in the seas, in Pre-Cambrian time, the latter assumption being rendered probable by the occurrence of the beds of limestone and contemporaneous (?) iron-ores and graphite in the Archean rocks of South Australia, and of limestone and contemporaneous (?) ironstone in the Archean rocks of Tasmania, and also by the great diversity of forms of animal life met with in the succeeding Lower Cambrian rocks.

"The earliest known folding of the Australian region took place in Pre-Cambrian time in Australia and Tasmania, and, at least, as far

back as Pre-Silurian time in New Zealand. In Victoria, South Australia and Tasmania, the original lines of folding along the Tasmanian and Adelaide axes continued to be developed all through the Cambrian, Silurian and part of Devonian time, and along the Tasmanian axis during a portion, at least, of the Carboniferous Period. The Kosciusko axis, however, would appear to be of somewhat later origin than the Tasmanian and Adelaide and New Zealand axes. Possibly, an extension northwards of the Kosciusko axis in Carboniferous time reclaimed for the Australian Continent an area in New England, part of which had formed the floor of an ocean of moderate depth.

"At least five important foldings have taken place in the Australasian region between Pre-Cambrian and Carboniferous time inclusive, and each has had an important influence on the evolution of the continental area of Australia, but the last extensive folding, that of the Gympie, which took place in Carboniferous time, has been the chief factor in the evolution of the Main Dividing Range of Eastern Australia in the northern portion of New South Wales and in the greater part of Queensland.

"The folding along the New Zealand axis which commenced in Pre-Silurian time, was continued up to the close of the Mesozoic Era." (Proceeds. Linn. Soc. N. S. W., 2d Series, Vol. VIII, 1894.)

The Carboniferous System of Brazil.—In view of the recent discussions of correlation of the Upper Carboniferous formations of Brazil, Professor Derby has published a description of material collected from Amazonian localities. The list includes 122 species from Upper Carboniferous strata. The descriptions are prefaced with remarks on the geology of the localities in which this fauna is represented, and a comparison between the fauna of Lower Amazons and that of Southern Brazil is given as follows:

"Although there is, on the Lower Amazons, a considerable thickness, probably from 1000 to 2000 feet, of supposed Upper Carboniferous rocks, all the known fossils are marine and form a single, or two closely related horizons. As stated in my paper on the Brachiopods, the Andean Carboniferous fauna is about of the same horizon. In southern Brazil, where there is an extensive Carboniferous area, freshwater conditions seem to have prevailed and marine fossils have thus far proved to be rare and unsatisfactory. So far as their characters have been made out, they agree with the prevailing vegetable and reptilian types in presenting a decided Permian, or, perhaps, early Secondary facies. Both in its physical and in its paleontological

characteristics this formation of southern Brazil offers considerable analogies with those of South Africa, India, and Australia, containing the Glossopteris flora (see Waagen, Neues Jahrbuch, 1888, II, pp. 172–177). If, on further study, this analogy is found to hold good, we shall have at, or near, the close of the Paleozoic, two strongly contrasted chains of similar formations extending from east to west across the whole present land area of the globe. The one with an abundant and characteristic marine fauna reaches from China to Bolivia with the Salt Range and the Lower Amazons (also the Pichis River locality in Peru) as intermediate links; the other, with predominant freshwater and terrestrial conditions, reaches from Australia through India and Africa to southern central South America." (Journ. Geol., Vol. II, 1894.)

The Affinities of Agriochaerus.—In determining the relationship of Agriochaerus to the Oreodontidae, Dr. Scott briefly recapitulates the resemblances and differences of the two families, and gives, as a conclusion, that Agriochaerus is the last term in a succession of species which form a curiously specialized offshoot of the Oreodontidae, its divergencies from that family being principally the results of a change in the functions and uses of the feet. The separation of the two series was probably already established in the Uinta Eocene, for, in spite of its somewhat intermediate character, Protoreodon can be a forerunner only of the oreodonts. The Bridger beds may be expected to yield the common ancestor of the two series, and this animal will probably turn out to be a pentadactyl form, with buno-selenodont dentition and quinquetuberculate upper molars, the unpaired lobe in the anterior half of the crown. (Proceeds. Amer. Philos. Soc., Vol. XXXIII, 1894.)

The Mastodons of Russia.—The conclusions reached by Mme. Marie Pavlov in her study of the Mastodons of Russia and their relations to the Mastodons of other regions, are as follows:

(1) It is the group of *Mastodon* called *Zygolophodon* represented by *M. borsonii, M. americanus*, and their varieties, which had a very great distribution in southwest Russia during the Miocene and Pliocene periods.

(2) None of these forms is specific to Russia, all having been widely spread in West Europe and North America.

(3) The group of *Mastodon* called *Bunolophodon* is known only till now through a very limited number of specimens of *M. arvernensis*,

while this group is widely represented in West Europe, Asia and America.

(4) The close resemblance between the Mastodons of Eur-Asia and America confirms once more the connection which exists between the two continents during the Tertiary period. (Bull. Soc. des Naturl. Moscou, 1894, No. 2.)

Geological News.—Paleozoic.—In a paper on the Potsdam and calciferous formations of Quebec and Eastern Ontario, Mr. R. W. Ells submits evidence to show that the real line of division between the Cambrian and Cambro-Silurian systems should be placed at the close of the Georgia slate and red sandrock divisions, and that the series from the base of the typical Potsdam sandstone to the summit of the Utica and Hudson River formations should constitute the system known as the Cambrian-Silurian or Ordovician, in view of the fact that there is no stratigraphical break in the sequence of these formations, nor any want of harmony in the succession of organic life as furnished by the evidence of the contained fossils. (Trans. Roy. Soc. Canada, Section IV, 1894.)

The report on the Insect Fauna of the Rhode Island Coal Field, by Dr. Scudder, is published as Bulletin No. 101 of the U. S. Geol. Survey. The collection is an unusually interesting one, as all the species, without exception, are new to science and unknown elsewhere. They consist of Anthracomartus, the first discovered Arachnid in the Carboniferous deposits in the eastern United States; a new genus of Neuropteroidea and one of Protophasmida allied to some from the Carboniferous beds of Commentry, in France; and a number of cockroaches, represented only by their wings. These last show great variety of form. The two subfamilies of Palaeoblattariae are represented by three genera, including nearly a dozen species.

Mesozoic.—Various offices have been attributed to the Aptychus, but the recent discovery of an Ammonite (*Oppelia subradiata* Sow.), from Dundry, now in the British Museum, with the Aptychus *in situ* closing the orifice, would seem to disclose the true nature of that body, viz., that of an operculum. In view of this fact, Professor E. H. L. Schwarz shows how all the theories against its use as an operculum can be met with equally plausible ones in favor of that view, and throws the weight of his opinion in favor of such use. (Geol. Mag., Oct., 1894.)

A large Clypeastrid is reported from the Cretaceous formation near Colorado Springs, Colorado. Upon examination, Mr. F. W. Cragin

pronounces it not only the type of a new species, but a new genus also, which he calls Scutellaster. He believes that this genus may be regarded as a synthetic or generalized type from which have been evolved *Scutella* on the one hand and *Clypeaster* on the other. (Am. Geol., Feb., 1895.)

Recent collections from the Cretaceous Formation on Long Island have yielded forty-six additions to the previously recognized cretaceous flora of that region, nine of which are new species. They are described and figured by Mr. Hollick. (Bull. Torrey Bot. Club, Vol. 21, 1894.)

The presence of silicified paleozoic fossils in the Long Island gravel at Lloyd's Neck, and in the vicinity of Glen Cove, establishes its identity, in Mr. Hollick's opinion, with the "yellow gravel" of New Jersey. The author is inclined to refer some of the gravels on Martha's Vineyard to the same horizon. In the same paper the author discusses the Cretaceous clays of Long Island, and in view of the evidence of the fossil flora he correlates them wiih the Amboy clays of New Jersey, the Dakota group of the west, and the Lower Atane beds of Greenland. (Trans. N. Y. Acad. Sci., XIII, 1894.)

BOTANY.[1]

Nitrogen Fixation in Algæ.—The following results of research on this subject since 1892 are thus summarily stated in a recent number of Nature. They are chiefly derived from the papers of Grossowitsch, Schloessing, Laurent and Koch. Their observations shed much light upon the question of the relations exisiting between Algæ, microorganisms, and atmospheric nitrogen. They show:—

(1) That at least two Algæ—Cystococcus and Stichococcus—possess no "fixing" powers in themselves.

(2) That many Algæ, taken together with certain microörganisms of the soil, do possess the power of assimilating atmospheric nitrogen.

(3) That this power is much increased by the addition of such organic substances as sugar.

It should be noticed that among the ten cultures used in the second set of experiments, only two contained definitely isolated algal species, viz. the cases of the two cultures of Cystococcus and soil-bacteria.

It was just in this instance, moreover, that it had been shown that the Alga itself had no capacity for fixing atmospheric nitrogen. Accordingly there could be little doubt that it was through the agency of the microörganisms that the "fixation" had taken place in these latter cultures.

The experiments of Laurent and Schloesing had shown that if in a culture of Algæ and bacteria endowed with "fixing" powers, the Algæ were destroyed, the bacteria lost partly, if not entirely, this capacity, which the mixture had possessed. This pointed clearly to the fact that there was some close relationship existing between the Algæ and microorganisms.

There are many facts which seem to indicate the nature of this relationship.

Berthelot found that the nitrification of the soil only took place as long as organic compounds were present; if these were exhausted, the nitrifying process ceased. Gautier and Dronin also showed the importance which organic compounds have with respect to nitrification. Kossowitsch's own experiments, in which the advantage of adding sugar to the culture was shown, also point in the same direction.

From such observations as these, Kossowitsch concludes that the relationship which the Algæ bear to the microörganisms is one con-

[1] Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.

nected with the organic food supply of these latter; he thinks that the Algæ, furnished with nitrogen by the bacteria, assimilate the carbohydrate material, part of which goes to their own maintenance, but part also to that of the microörganisms. It is, therefore, in his belief, an instance of symbiosis in which each supplies the wants of the other. There are many facts, partly the result of his own observations, partly the result of those of others, which uphold this view. If the mixed culture be placed in the light, there is a far more noticeable nitrogen increase than when in darkness. Again, if a rich supply of carbon dioxide gas be provided, this is marked by a decided rise in nitrogen-fixing powers. Both these conditions are such as are known to influence carbohydrate assimilation in chlorophyll-containing organisms; but all experience is antagonistic to the view that light should be beneficial to the vital activity of the bacteria, and there are only one or two exceptional instances (Nitromonas, etc.) in which carbon dioxide can be directly assimilated by these microörganisms.

Moreover, in the cases where the bacteria are bought into immediate contact with the Alga, as in those species of Algæ which are enveloped in a gelatinous covering wherein the microörganisms become imbedded, nitrogen fixation appears to be greatly aided, and the addition of sugar to the culture has no such marked effect as in the instances where non-gelatinous Algæ are employed. The explanation of this seems to be that the bacteria embedded in the gelatinous sheath are amply provided with carbohydrate food without the addition of sugar, which, therefore, comes more or less as a superfluity.

All this seems to justify Kosswitsch's view of the part played by the Algæ in the fixation of nitrogen; it appears to show that they have an indirect, but none the less important, influence upon the process. (Nature, Jan. 24, 1895.)

RULES FOR CITATION

Adopted by the Madison Botanical Congress and Section G, A. A. A. S.

Writers and publishers of botanical matter are earnestly requested to adopt the forms here recommended. Examples of various citations illustrating the application of the rules in specific cases are given. Correspondence may be addressed to Secretary of the Committee on Bibliography, 1284 Massachusetts Ave., Cambridge, Mass.

In each complete citation there should be given the following items:

a. Author's surname in full, followed by a comma.

b. Exact title, verbatim, following the capitalization required by the usage of the language in which the title is written, but not necessarily the capitalization employed.

c. Name of periodical or work, abbreviated in accordance with list of journals and catalogue of authors under recommendation 1. *a. b.**

d. Series, if any, in Roman capitals.

e. Volume number in bold face Arabic numerals, followed by colon. In case there is no volume number, the number of the part, heft, lieferung, or fascicle is to occupy this place but is to be printed in Arabic numerals of ordinary face. When a volume is composed of parts separately paged the number of the part shall be written as an index figure to the volume number. Volumes in parts with continuous paging require no designation of parts.

f. Page, in Arabic numerals of ordinary face. In case paging of the paper is in Roman numerals these should be used, preferably small caps. Re-paging in reprints and separates is to be indicated by enclosing the numerals in parentheses. In case the original paging is unknown an em dash should occupy its place, the reprint paging being given in accordance with the foregoing

*See Proc. Mad. Bot. Cong. 45. Je 1894.

rule. No individual or unique paging is to be cited under any circumstances.

g. Figures, plates and exsiccatæ are to be printed in Italic Arabic numerals, the number designating the figure or plate to be preceded by the abbreviations *f.* and *pl.*, respectively, in Italics. *d.* following a page number may be used, when desired, to indicate description of a species.

h. Exact date must be given if possible, written in the mode and with the abbreviations for months used by Library Bureau.* The year at least must be given.

i. Punctuation. Except the comma following the author's name, and the colon following the volume number all the items are to be separated by periods. If another citation follows in the same line it is to be separated from the first by an en dash. Specific, generic and varietal names are to be written and punctuated in the method used in the "List of Pteridophyta and Spermatophyta" issued under the direction of the Botanical Club, A. A. A. S.

j. If it is considered desirable to give other data than series number (if any), volume number, page and date, these should be added in brackets after the date. But useless or unnecessary data should be avoided.

k. Citations of reviews, abstracts, and all such secondary references should be enclosed in parentheses.

Examples.

1. **Lagerheim, G. von.** Ueber das Vorkommen von Europæischen Uredineen auf der Hochebene von Quito. Bot. Centralb. **54**: 324–331. 1893.

2. **Trelease, W.** A revision of the American species of Epilobium occurring north of Mexico. Rept. Mo. Bot. Gard. **2**: 69–117. *pl. 1–48.* 22 Ap 1891.

3. **Sargent, C. S.,** Editor. Populus monticola. Gard. and For. **7**: 313. *f. 56.* 8 Ag 1894.

*Those abbreviations are as follows: Ja, F, Mr, Ap, My, Je, Jl, Ag, S, O N, D; i. e., the initial of the month followed by the first distinctive letter.

4. **Dietel, P.** Die Gattung Ravenelia. Hedw. **33**: 22–48. *pl. 1–5.* 30 Ja. 49–69. 15 Ap 1894.

The foregoing are correct forms for catalogue by author. The following illustrate cases arising under the rules indicated by the letter preceding.

5. Ell. and Everh. Pyren. 491. My 1892.

6. e. Proc. Phil. Acad. **1894**: 53–59. 1894.

The year number, 1894, is the volume number, and not necessarily the year of publication. E. g.,

7. e. Bessey, Am. Pomol. Soc. **1885**: 42. 1886.

8. e. **Mez, C.** Bromeliaceæ. III. Flora Brasiliensis 115: 425–634. *pl. 81–114.* 1F 1894.

Not Fasc. CXV, 425–634, t. 81–114.

9. e. **Saccardo, P. A.** Syll. Fung. 7^2: 481. N 1890.

10. e. j. Bull. Geol. and Nat. Hist. Surv. Minn. 9: 39–42. 2 Mr 1894.

Not 9^2; nor 9 part 2; nor 1894 [part 2].

11. e. j. Linn. Sp. Plant. 6^2: 125. 1852. [ed. Willd.]

12. e. j. **Gray, A.** Man. Bot. 225. 1890. [6th ed.]

13. f. **Peck, C. F.** Rep. N. Y. Mus. **47**: —(18). N 1894.

14. g. Ell. and Everh. N. A. F. *1642.* F 1889.

15. g. Rept. Mo. Bot. Gard. **2**: 98. *d. pl. 28.* 22 Ap 1891.

16. i. Beringer, Am. Jour. Pharm. **66**: 220. My 1894.—Tulasne, Ann. Sci. Nat. Bot. III. **7**: 85. *d. pl. 2. f. 3.* 1847.

17. j. **Bailey,** The Japanese plums in North America. Bull. Cornell Exp. Sta. 62: 3–36. Ja 1894. [Illust.]

The figures are not numbered.

18. k. Ell. and Kell. Jour. Myc. **1**: 12. *d.* Ja 1885.—(Hedw. **24**: 45 *d.* Je 1885.) Peck. (Grev. **22**: 111. Je 1894.)

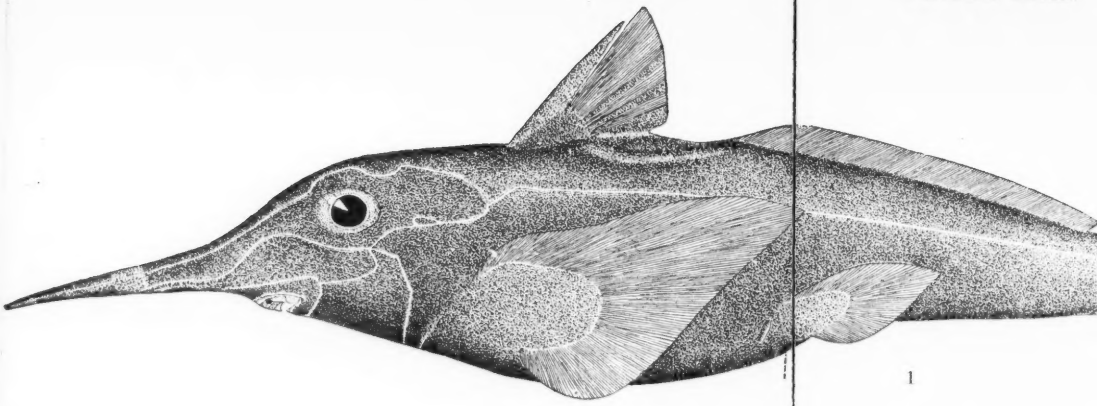
ZOOLOGY.

The Senses of Pilumnus.—The observations of M. Émile Racovitza prove that the otocyst of *Pilumnus hirtellus*, a small crab living in the rocks off Cape Abeille, near Banyuls, is an organ for feeling vibrations rather than for hearing. The crab feeds on small bivalves which live in holes in the rocks. When the bivalve moves its shell scrapes the rock and the vibration is communicated to the crab in his hole, whereupon he promptly sallies forth and proceeds in the direction of his prey, feeling for it with his claws. He appears to recognize his food by the sense of touch rather than sight, since any object used to scratch the rock will attract the crab and be seized by him as readily as if it were his favorite bivalve food. (Comptes rendus de l'Acad. d. Sci., CXVIII).

More Deep-Sea Fishes.—In the last number of the NATURALIST, we referred to the publication by Messrs Goode & Bean, of the U. S. Fish Commission, of some remarkable forms of deep-sea fishes dredged by the U. S. steamer Albatross. These were Hariotta, a new genus of Chimæroidei, at depths varying from 700 to 1000 fathoms; Rondletia, a new genus of Iniomi, from 1600 fathoms; and Cetomimus, also of the Iniomi, at from 1000 to 1500 fathoms. In the present number of the NATURALIST, we give figures of these remarkable forms, thanks to the Hon. Marshall MacDonald, U. S. Commissioner of Fisheries. We add to these, figures of three remarkable forms of the order Opisthomi, belonging to the families Notacanthidae and Lipogenyidae, the latter a new family defined by Prof. Gill. Two new genera of the former are called Gigliola and Macdonaldia respectively, and they are quite distinct from Notacanthus. Lipogenys possesses a peculiar suctorial mouth structure. The mandibular bones are said to be attached to the extremities of the maxillary, and to be "free behind." The lips are thick, rugose and contractile, and there are no teeth. The spinous dorsal fin is very short, and the eye is rather small. The only species is the *L. gillii*, which was taken at a depth of 865 fathoms.

We should have preferred seeing some more-conspicuous zoölogists commemorated by these discoveries than Harriott and Rondelet; and we have a feeling that gentlemen who have passed over to the majority like these two and Sir Walter Raleigh, do not appreciate the compliment as much as they would have done had they been still with us.

PLATE XIX.



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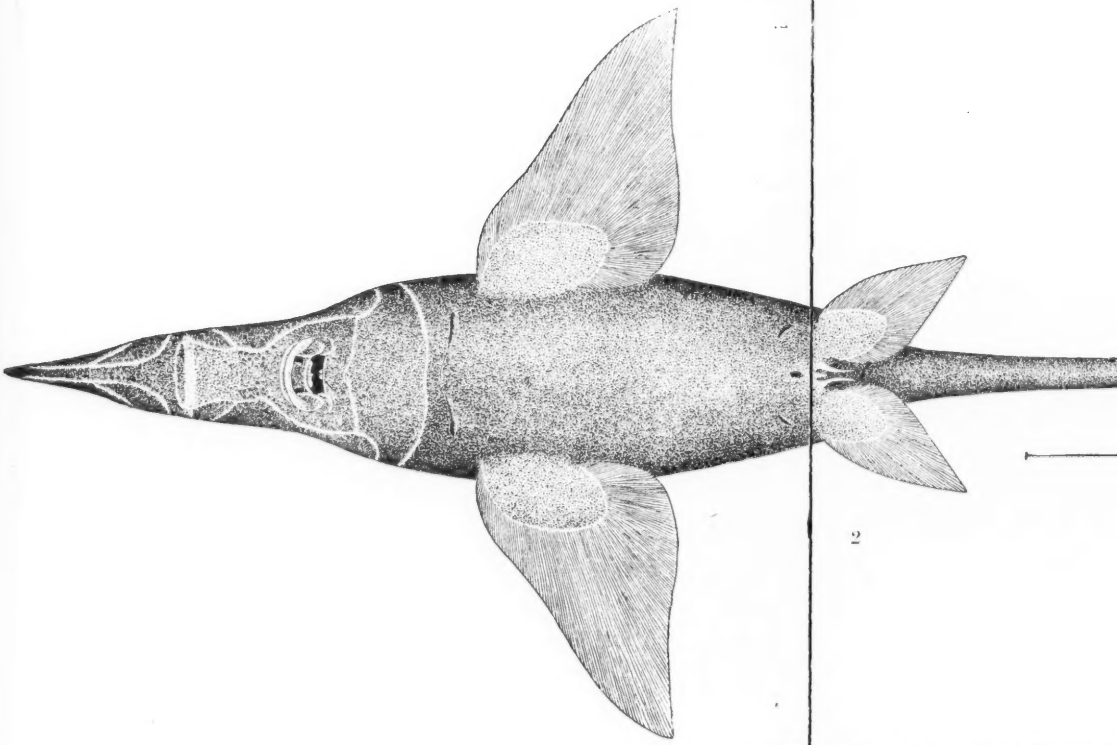
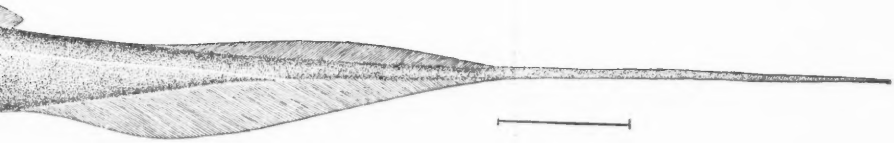
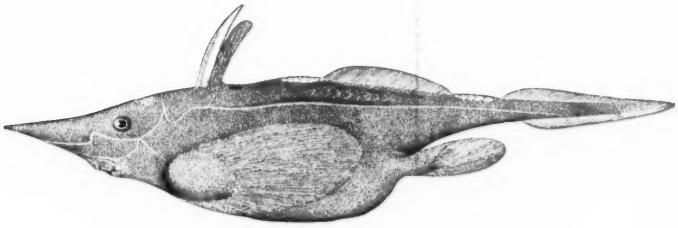


2

Hariotta raleighana G. & B; adult





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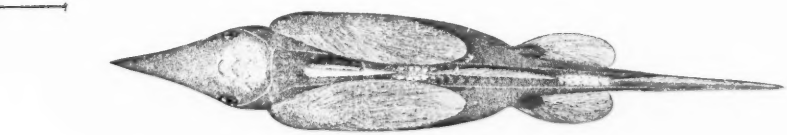

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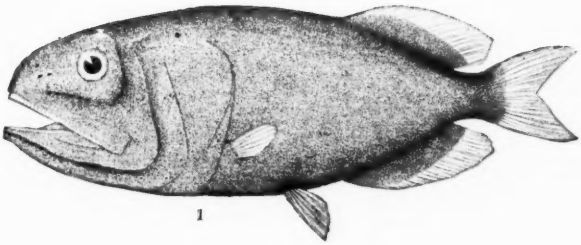
ult and young.

PLATE XX.



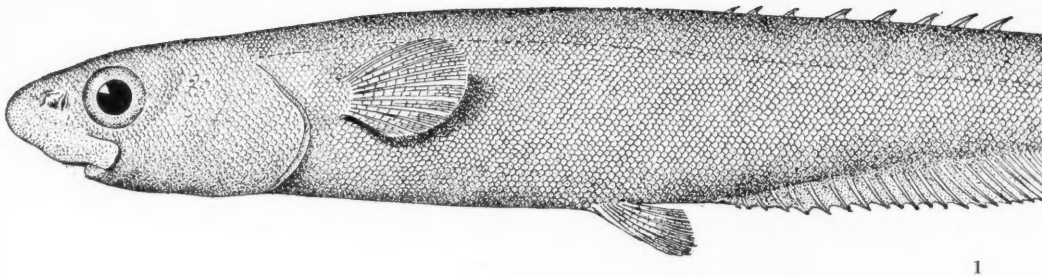
1

2

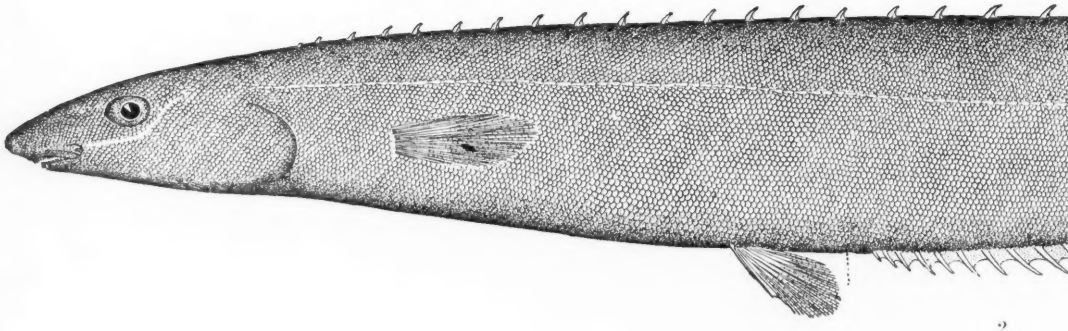
3

1. *Rondeletia bicolor* G. & B. 2. *Cetomimus gillii* G. & B.
3. *Cetomimus storerii* G. & B.

PLATE XX



1



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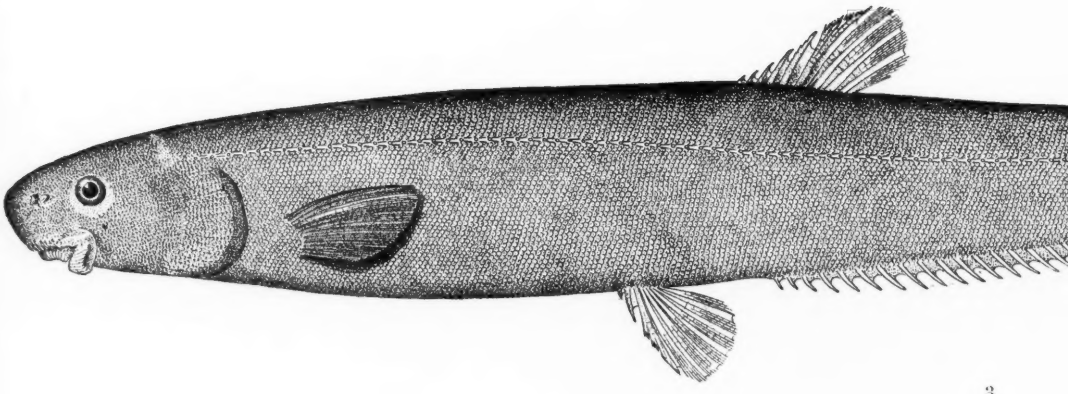
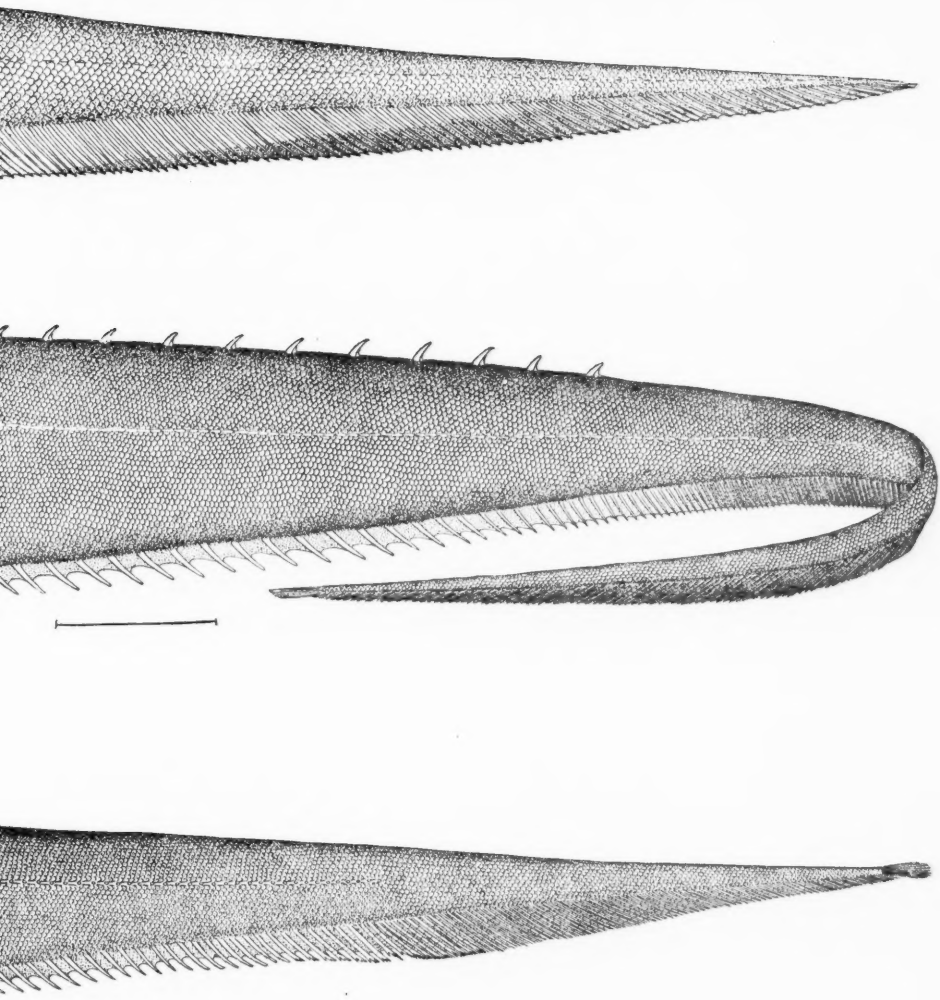


3

1. *Gigliolia moselyi* G. & B. 2. *Macdonaldia rostrat*

XI.



ta G. & B. 3. *Lipogenys gillii* G. & B.

Destruction of Food Fishes.—A gradual diminution of salt-water food fishes is reported all along the eastern coast of the United States. This destruction is caused by willful violation of game laws. The fish phosphate factories cause the disappearance of immense quantities of bluefish, bass and scup. The gill nets at the entrance to bays and harbors have almost exterminated the striped bass, which was once very plentiful, while early every spring pound nets are set for alewives, flatfish, smelts and flounders, and these are caught by the ton and spread upon the land as a fertilizer. The most destructive nets probably are the pounds, since they are made of fine meshed netting and cover an immense area. In some instances these nets are 4000 feet in length, and naturally catch immense quantities of cunners, killies, butterfish, white perch and young fry of the blackfish and sea bass which frequent our waters. It is to be hoped that stringent game laws will be adopted and that they will be stringently enforced. (Scientific American, Jan. 12, 1895).

A Swallow Roost at Waterville, Maine.—The following interesting account of a Swallow Roost is given by A. F. C. Bates in the January number of *The Auk*.

Not far from where a small stream called the Messalonskee joins the Kennebec River, one may see at evening, from the middle of July to about the third week in September, an interesting sight in the bird line.

The willow trees along the banks of this stream, particularly a close row some five or six hundred feet in length, form the roosting place of vast numbers of swallows. During the forenoon and early afternoon very few swallows are to be seen in the sky—indeed they are conspicuous by their absence—but a little before sunset the birds begin to arrive in the vicinity, flying, sailing, chasing each other around in the upper air, everywhere within the eye's reach. From north and south, east and west, in they come out of the distance till one thinks the barns, banks, martin-houses and swallow nests of whatever description all over Maine must have yielded up their inmates. Shortly after sunset they gather more nearly in the region directly above the trees, incomers from every point of the horizon still joining them, and toward the last exhibiting great hurry and intentness, as if fearful of being "late to meeting."

Then begin movements that are the most interesting feature of this gathering. At intervals *clouds* of swallows will evolve something like order out of their numbers and perform *en masse* some of the most

fantastic curves, spirals, counter-marches, snakelike twists and turns, with the sky for a background, that ever a company of genus Homo executed on a finely polished floor. For instance, one evening they separated into two parts, one going to the right, the other to the left, each division making a grand circle outward, then joining again for a forward movement. There were some stragglers, but the figure was distinct and was twice performed, with other evolutions interspersed. Then a long, snake-like movement from the upper air down, very slightly inclined from the vertical, with two twists in it, a loop around a tall tree farther down the stream and back, brought them into the tree-tops for roosting. That was the cleanest and most astonishing figure I ever saw them perform. Occasionally they drop down into the trees like pieces of paper, but oftener the final alighting is a combined movement, sometimes in the shape of an inverted cone—usually in a grand sweep after their most elaborate evolution. Frequently they swoop out from the trees company after company, several times before the last settling, their wings not only making a tremendous whirring, but a perceptible movement of the air. Their chattering keeps up from half to three-quarters of an hour after they settle in the trees, and their dark little bodies against the sunset sky look as numerous as the leaves. Often they weigh down a branch and then a great chattering, scolding and re-adjustment ensues. Sometimes there is a movement through the tree-tops to one spot as if a conference were called, and a more surprising amount of chattering than before. Then in a few minutes back they come till the tree-tops are about equally full. The noise which they make is suggestive of the whirring of looms in a cotton mill, heard through the open windows, or of some kinds of water-falls.

They leave the trees in the morning a little before sunrise. August 26th we watched them go out. At 4.15 there were sounds as if of awakening and gradually the noise increased. At 4.25 they began to arise in companies at intervals of two or three minutes. They did not remain long in the locality and by five o'clock not one was to be seen.

The Distribution of Seeds by Birds.—I have just sent a MS on The Dissemination of *Yucca aloifolia* to Professor Trelease for publication in the Missouri Botanical Garden Reports. My attention has been called to certain observations therein of a zoological nature that seem rather remarkable. I am convinced that the observations are correct, but am not informed on the literature of the subject and thus

do not know whether to consider the facts novel or not. Probably you may be able to inform me in regard to the subject.

In connection with my work on dissemination, I was led to feed a captured mocking-bird on various fleshy fruits. I found that they apparently digest their material with what would seem to me great rapidity. As illustrations, I fed the bird with some 15 seeds of *Yucca aloifolia*, noting the time when they were swallowed. One of these seeds, and there could be no mistake, was evacuated in slightly over 15 minutes after the first seed was swallowed, and the majority of the seeds were evacuated by the end of half an hour. At another time some 15 seeds were given to the bird and the majority were evacuated in half an hour and all in an hour. The bird was given access to an entire Yucca fruit and ate and evacuated 51 seeds in about 4 hours.

I tested the bird also with poke berries (*Phytolacca decandra*) and found that all excrement became stained in a very few minutes, while the seeds usually began to be evacuated in considerable numbers in half an hour and the majority had passed in three-quarters of an hour. The same held true with the seeds of *Durantia plumeri* and *Melia azederach*.

The question then is whether the evacuation of seeds in from 15 minutes to half an hour, making the entire passage of the alimentary canal in that time, would be considered at all uncommon. It may be that such fruits have a purgative effect on the bird and hasten matters somewhat. I would be greatly obliged for your opinion on this subject. I merely mention the thing incidentally in my paper, but my observations were carefully made.

H. J. Webber.

The Effects of Cold.—L'*Eleveur* reports that the wild boars, which are very numerous in the forests of Luxembourg, driven by cold and hunger, roam through the streets of the villages. Also that the wolves have come down from the Vosges Mountains to the plains in vast numbers. If these animals are experiencing such suffering through cold, it is not surprising to hear that the game birds in the preserves of Marly and of Rambouillet are perishing from the same cause. Each day the guards find great numbers of pheasants and partridges frozen to death. In this connection is mentioned a singular fact observed by an English farmer. He owned four peacocks which were in the habit of coming at his call. He noticed that for two days one was missing. The third day he saw two of the peacocks vigorously scratching away the snow to the depth of a meter. On going to

their assistance he found the missing bird buried in the snow and fastened down to the ground by his tail, which was frozen in a pool of water. A few hours after his release the peacock had perfectly recovered. (Revue Scientifique, Fev., 1895).

Zoological News.—A study of the Crista of the large intertropical Trombidiums (*T. tinctorium,* etc.) leads Dr. Trouessart to the conclusion that the organ in question is not only an organ of hearing, but that it is also the remnant of the median anterior eye, now atrophied. This example of organs of different senses joined together by growth is unique among Arthropods, although there are cases among certain insects where antennae are found inserted near the centre of the eyes. (Bull. Soc. Entomol., Paris, 1894).

In Chapman's "Guide to a Collection of Birds found within 50 miles of New York City," it is stated that 348 species are known within that radius, and these are classified as follows: Permanent residents 35; summer residents 92; winter residents 36; summer visitants 18; winter visitants 16; regular transient visitants 82, irregular 30; accidental 39. The collection belongs to the American Museum of Natural History.

ENTOMOLOGY.[1]

Two more new species of Lecanium.—(1). *Lecanium pseudhesperidum*, Ckll., n. sp.—♀ scale of the general shape and appearance of *L. hesperidum*, but (at least in spirit) firm in texture. Length 6½, breadth 3⅔, height 1 mm. Color reddish-brown, moderately shiny, pitted but not ridged or grooved; rows of apparently glandular patches on the dorsum. This description is from a ♀ packed with eggs; empty ♀, from which the eggs have hatched, are sometimes rather larger, and appear whitish or nearly colorless.

Derm colorless, very distinctly tessellated, the tessellations not containing gland-spot. Rather large gland-pits scattered at irregular intervals.

Margin with slender spines, often curved, never branched. Lateral incisions each with a stout blunt brown spine, and a second rudimentary or very small. Anal plates small, about 1⅓ mm. from hind end. Anogenital ring with numerous hairs. Mentum 2-pointed, rounded at end.

Legs ordinary; coxa and trochanter each with a hair at end; tarsus scarcely if at all shorter than tibia. Claw stout, hooked at tip. Digitules ordinary, well-developed, slender but not filiform.

Antennæ very pale brownish, well-formed, but the joints indistinct, 6 joints, 3 much longest, about twice as long as 2, and a little longer than 4+5+6. 4 shortest, then 5 and 1 about or nearly equal. 6 about as long as 2. Formula 3(26)(15)4. 1, 2 and 3 each with a long hair near the end; 6 with many hairs.

Hab., on *Cattleya* in greenhouse at Ottawa, Canada (C. E. F.), Dec. 15, 1894. Sent by Mr. J. Fletcher. The native country of the species is unknown, but it is most probably neotropical.

This interesting species looks very like the common *L. hesperidum*, but in its tessellated skin more resembles such species as *L. depressum*. The tessellation is microscopical, so the species could not be taken for *L. perforatum* as *tessellatum*. With it were sent (also in alcohol) three or four examples of an *Aulacaspis* from the same plant. No satisfactory study could be made of this from the material received, but it appears to be *A. boisduvalii*, (Signoret).

(2). *Lecanium lintneri*, Ckll. and Bennett, n. sp.—♀ scale very flat, practically circular in outline, about 5½ mm. long and 5 broad; dark

[1] Edited by Clarence M. Weed, Durham, N. H.

chestnut brown, shiny, subreticulately wrinkled. Removed from the bark it leaves a rather indistinct white patch.

♀ " Derm orange-yellow, with gland orifices. Marginal hairs short, scattered.

" Antennæ seven-pointed, 7th joint about ½ longer than 1st, emitting 4 or 5 long hairs. 1, very broad, a little broader than long. 2, about as long as 1 is broad, 3 a little longer than 2 ; 4 a little longer than 3, the point between 3 and 4 being almost indistinguishable, causing 3 and 4 to appear as one long joint. 5, two-thirds as long as 2. 6, a little longer than 5. Formula 4(73)2165.

" Legs: coxa short, broad, has one hair ; trochanter almost as long as coxa ; femur 2 times as long as coxa ; tibia ¾ as long as femur ; tarsus shorter than tibia. Claw small, not curved. Big knobbed digitule on tarsus larger and thicker than on claw. Anal ring with long hairs, perhaps only 6." (Joseph Bennett, MS.)

Hab.—On Sassfras, Lake Mohonk, Greene Co., N. Y., June 15, 1894. Found by Dr. Lintner, to whom it is dedicated in recognition of his great services to N. Y. Entomology. The material was small in amount, and were the species not so very distinct from anything yet described I should hestitate to publish it. The scale is not very unlike that of some *Pulvinaria*, but there is no ovisac, though young had been produced by the specimens examined. *Lecanium tulipiferæ* Cook, as figured by its author, looks as if it might possibly be this species ; but the figures are bad, and I have received from Mr. L. O. Howard good specimens of *tulipiferæ*, from Virginia. These specimens show that *tulipiferæ* resembles such forms as *tiliæ* and *æsculi*, and has nothing to do with *lintneri*.

Most of the description was written by Mr. Bennett, a former student of mine.

T. D. A. Cockerell, N. M. Agr. Exp. Sta.

A new Trombidian.[2]—The accompanying plate XXII shows a new North American trombidian which the writer found on the feathers of the black flycatcher (*Phœnopepla nitus* Sev.) from Casa Grande, Arizona. By way of introduction some notes about this species may be outlined before the more detailed description is given, which is left till the last. This mite appeared on the surface of the plumage of two dried skins of the above bird, which had been laid away after separating from the flesh, for a time enclosed in paper cylinders. This fact

[2] Read before the Entomological Section of the Chicago Academy of Sciences, January 18th, 1895.

is mentioned as they proved useful in preserving the mites which had previous to their death made their way to the surface of the feathers. In the uncovered skin, moreover, parasites make an effort to crawl away or are lost in handling. It is not known on what part of the tissues of the bird the present species of parasite inhabits, but from the knowledge given to us by the writers mentioned further on, we may infer that either the connective tissue or the feather furnishes its nourishment, or, perhaps, as in the case with some other members of trombidians (Cheyletinae) they may feed upon the other forms of parasites which frequently live upon the same bird. All this is speculative with relation to the new species under consideration as we have not had as yet an opportunity of personally examining living specimens.

On the shining black back ground of feathers this mite appears as minute whitish specks distributed quite generally over the body of the two birds seen. They are easily removed with the point of a needle to which they can be made to adhere by mere contact, by reason of the long hairs which is such a characteristic feature of the example before us. By reason of this also I have given it the name *villosa*. Transferred to the slide of the microscope they are seen to be shrivelled and of course lifeless. An immersion in pure glycerine caused the tissues to regain to a striking extent what would apparently be the natural rotund appearance of life. Some twelve specimens of both sexes gathered from the birds were studied, the most of these being matured individuals. Selecting one which was characteristic, I made the drawing of the female referred to in the beginning of this paper. While a number of species have been described, from time to time, the literature is not extensive and that which interests us most in the present connection is foreign. In 1878 G. Haller[3] found a remarkable vermicular shaped trombidian in the connective tissue of the ash-colored woodpecker (*Picus canus*) and described it under the generic and specific appellation *Picobia heerii*. In the following year 1879, A. Heller of Kiel, found similar forms inside the feathers of poultry, pigeons, and peacocks. To all appearances these Acarina all belong to the same genus *Picobia* notwithstanding the latter observer described two new species under a newly created genus to which the name Syringophilus was given. We could not pass without mentioning this as we think the new form here described, for the first time, enters into the genus Picobia of Haller, while it resembles, as far as description goes, to some extent the species *Picobia* (*Syringophilus*) *uncinata* Heller.[4]

[3] Freyana and Picobia Zutschrift fur wissenschaftliche, Zoologie, XXX, 1878, p. 81.

[4] Die Schmarotzer, 1880, p. 186.

Description of *Picobia villosa*, sp. nov.—Length of body, male .7 mm. breadth .20 mm. The female is slightly larger. Body elongated, rather rotund; palpi abbreviated; legs strong with five joints; tarsus of all the legs terminating in two chitinous Ctenidium or comb-like structures, the body of the latter thickened, convexed on the outer side straighter on side giving origin to the teeth, at point of attachment to tarsus the diameter is lessened and becomes rounded between the claws, the teeth constituting the comb are graduated in length being longest at free end, becoming shorter toward tbe articulation as shown in Fig. 2, the teeth are also notched at their extremities the last tooth of the fourth pair having six denticles. Within the end of the tarsus, on each side, is inserted, by a stalk, an accessory delicate hyaline vertically flattened appendage, see Fig. 2a, it is split up a part of the way into about nine sharp terminations which divaricate slightly; they project to the outer side of the claws, their ends overhanging like fringe. At the end of the tarsus, corresponding to a point at the base of the combs, two curved claws are present as shown in Fig. 2. To the naked eye the body of this mite is whitish. Through the microscope it appears almost transparent except where food masses occur in the abdomen. A number of blackish hairs are found, on the legs, body, and especially at the end of the abdomen where some, here, attain an extraordinary length. In the plate these are curved so as not to take up unnecessary room.

Explanation of Plate XXII.

Fig. 1. *Picobia villosa* Hancock, original, greatly magnified, semi-transparent view.

Fig. 2. Tarsus seen from the side showing comb structures, the claws, and accessory stalked appendage (shown at a).

Chicago. Joseph L. Hancock.

PLATE XXII.

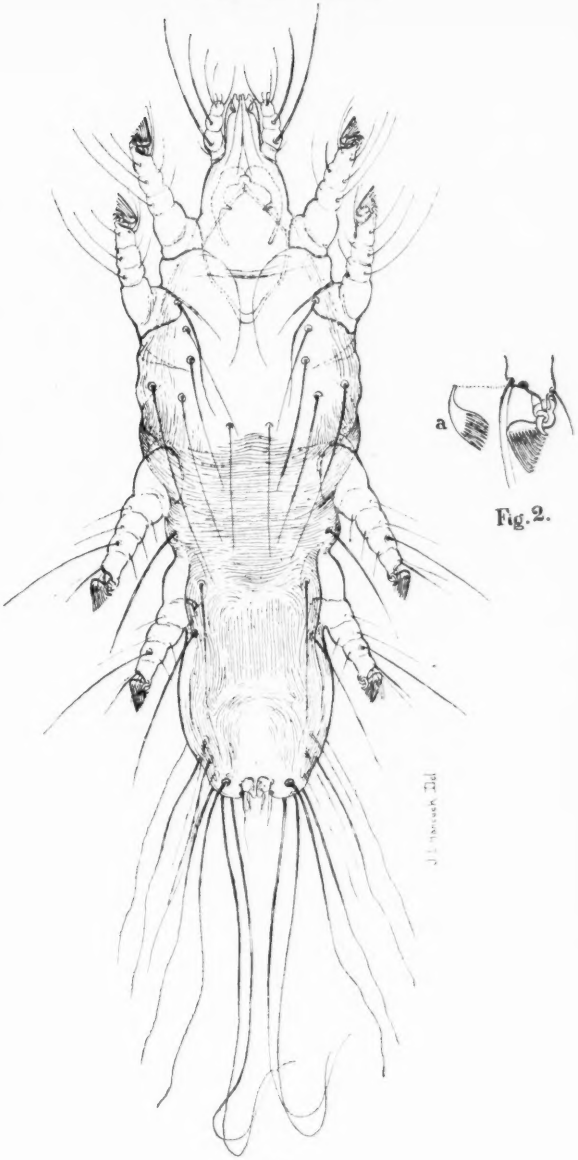


Fig. 2.

Fig. 1.
Hancock on Picobia.

EMBRYOLOGY.[1]

Cytotropism.—Professor Wilhelm Roux, the leader of the new school of Embryology that seeks to investigate developmental phenomena by the aid of experimental methods, has published in his new periodical some very interesting results obtained on his often used object, the frog's egg.[2]

The eggs were teased apart in salt solution, white of egg, or in a mixture of both, and observed under precautions necessary to prevent currents and jars in the liquids. When so treated the isolated cells, for eggs are used in later cleavage and bastula stages when each is divided up into many cells, lie in the liquid at varying distances from one another and quite separate.

It is now found that movements may take place that results in the union of some of these isolated cells. These movements are a gliding or creeping, since the cells lie on the glass slide and not suspended in the liquid. In many cases, especially when salt solution is used, the cells throw out pseudopodia that may be all clear protoplasm or else contain a granular axial mass. These may anastomose with pseudopodia of other cells. The pseudopodia, however, are not concerned in the motions which are actual translations of entire cells without any visible means or cause.

The movements do not take place between all cells and seem to vary in power in the same cells. In the frog *Rana fusca* eggs from the latter part of the breeding season show no movements. In other species namely *R. esculenta*, *Bombinator igneus* and in the fish *Telestes agassizii* no movement could be detected.

In detail these movements are found to be of limited extent but yet capable of resolution into considerable complexity. Only cells having diameters of from 20 to 60 microns show the phenomena and only when not more than their own diameter apart. We are thus dealing with migration of small amounts of matter along very short distances. The cells move along the shortest distance between them but not without vibrations from side to side. The latter part of their course when about to unite is generally more rapidly accomplished than the first. A few minutes to an hour or two may be taken in moving these short distances, e. g. 40 microns.

[1] Edited by E. A. Andrews, Baltimore, Md., to whom abstracts, reviews and preliminary notes may be sent.

[2] Archiv f. Entwicklungsmechanik, Vol. I. Oct. and Dec., 1894.

Larger cells may move toward smaller and vice versa, or both toward one another.

When three cells are concerned one may move toward another directly or may at first move as if in the resultant line of forces proceeding from each of the other two.

Mass does not seem concerned in these movements for several cells in a group (not separated from one another in the teasing) do not act as a whole, but one of them may attract or else be attracted by some isolated cell lying near.

Many cells may eventually come together and form a firm aggregate out of a scattered collection of isolated cells.

It appears that these attractive movements take place between cells of separate eggs as well as between the cells of the same egg. Moreover, it was found that the cells of later stages, of the gastrula and young tadpole stage, may move. Thus cells that were forming the nervous system may, when isolated, round themselves off, become amœbird and even, in some cases, draw together till they touch.

Besides the change of position hitherto mentioned there is a marked change of form. In general two active cells protrude on the side towards the other cell so that they may be said to flow out towards one another to a certain extent. There is also considerable change in outline, elongation and contraction of the cell while moving or while serving as the centre of attraction or of movement for another cell.

A cell may even divide while also moving towards another.

The explanation of these complex movements of isolated cells in the frog embryo remains for the future, but provisionally the author refers them to the general class of movements brought about as the result of chemical action. That they are not simply physical, but results of life in the cells, the author seems to prove by careful examination of the sources of error and by controlling the conditions of experimentation.

He would class these movements with those of sperm cells towards ova and of conjugating infusoria towards one another as cases of CYTOTROPISM; he pictures to himself a chemical or chemotactic source for the movements by supposing that the cells secrete chemical substances that effect other cells so as to direct their movement as well as to incite it. This movement under the stimulus of adjoining chemicals would differ from that observed by Pfeffer, in that here the cell does not move towards the region of greatest concentration of substance, but, in that it moves to another cell and thus into the field filled by substances from two cells, towards the region where the substance is least dilute.

Since this cytrotropic state seems to vary in any cell it may play a varying and not unimportant part in the phenomena of ontogeny.

By its instrumentality, cells may, at one time unite, at another, remain separate. Migrations of cells towards oxygen on the surface of the egg, etc., would also be exhibitions of these same cytrotropic powers.

PSYCHOLOGY.[1]

In his "Introduction to Comparative Psychology," (*Contemporary Science Series*, Walter Scott & Sons, London), Professor Lloyd Morgan's central object is, he tells us in his preface, "to discuss the relation of the psychology of man to that of the higher animals...a secondary object...is to consider the place of consciousness in nature, the relation of psychical evolution to physical and biological evolution and the light which comparative psychology throws on certain philosophical problems." As far as the formal element in his book is concerned, Professor Morgan makes no claim to originality. He has made use, so far as I can see, of three architectonic principles. The first of these is the symbolic conception of consciousness as a "wave;" the crest of the wave corresponds to the "focus of consciousness," more usually called the centre of attention, while the other portions of the wave represent the "marginal" elements, those of which we are conscious but to which we are not attending. The second is the conception of "relations" as "the momentary feelings accompanying transitions in consciousness." The first of these conceptions Professor Morgan credits to Professor James, of Harvard; the second to Mr. Spencer. The third principle he does not explicitly mention in his preface, probably because it would be difficult to ascribe it, in the form in which it is stated by himself and others, to any given individual. It is the conception of a selective, synthetic activity as characteristic of subject and object alike; this, in the object, is the activity manifested in the objective sequences which are formulated as natural laws; in the subject it is that "to which the term Will is properly applicable" (page 315).

In the few pages of Prolegomena the doctrine of monism is briefly outlined, first, as the monistic theory of knowledge, second, as the monistic interpretation of nature, third, as a monistic analysis of nature into mental and material "aspects," distinguishable in thought but not separable in existence. The first three chapters prepare the way for the detailed discussion that follows. The conception of consciousness as a wave is made plain in chapter I; in chapter II, on the "Physiological Conditions of Consciousness," it is shown that it matters little whether we take as our working hypothesis the pure monistic

[1] This department is edited by Dr. Wm. Romaine Newbold, University of Pennsylvania.

identification of the mental and physical series or the empirical dualism commonly known as the doctrine of parallelism. Chapter III inquires into the inevitable limitations of the method of analogy as applied to the interpretation of other minds than ours.

In the thirteen chapters following, Professor Morgan applies himself to the purely psychological part of his work, and throughout, after devoting a chapter or two to the analysis of the phenomena of the human mind, he endeavors in the next chapter to determine whether analogous mental states are to be ascribed to animals other than man. He begins his inquiry with the more concrete phenomena of the specifically inner life and concludes that in the lower animals concrete representative ideas are suggested by sense impressions, associated with one another and remembered very much as they are in ourselves. He then takes up the difficult problems of sense experience in the chapter on the "Analysis of Impressions;" the ultimate elements of impressions are distinguished as sensations of various kinds; the chapter on "Synthesis and Correlation" then undertakes to show "how these sensation elements are combined synthetically to form impressions as we know them; how they enter into correlation with each other; and how they call up through association representations of similar sensation elements." Under the caption "The Sense Experience of Animals," Professor Morgan gives his reasons for concluding that the sense experience of the higher vertebrates is much the same as our own, while of that of the lower forms of life we probably can form no representative idea whatever.

Chapter XI develops in sharp relief the doctrine of lower (i. e. subcortical) automatic centers standing under the control of higher (cortical) centers whose augmenting or inhibitory activity is in turn determined by sensory (conscious) centers. The activities of these latter centers, again, are determined by the emotional tone associated with their functioning. Professor Morgan also inclines to the belief that special centers exist for the control of these purely sensory centers (pp. 194–5). Chapter XII, entitled "Instinct and Intelligence," applies these principles to the explanation of the conduct of animals, showing that while animals may act instinctively, their habits are for the most part empirically determined by the method of trial and error, and consequently must be regarded as fully conscious. To this method of trial and error Professor Morgan would restrict the term intelligence.

Chapters XIII and XV on the "Perception of Relations" and "Conceptual Thought," are perhaps the most suggestive in the book. A relation is the transition between two focal states of consciousness;

originally marginal, it in the course of evolution becomes focal. This is probably due to the necessity of intercommunication, which can be carried on in terms of relation only, and language has been the instrument by means of which this immense advance in mental evolution has been effected. When a given relation is not only itself focal, but is apprehended without reference to any particular terms related, it is called a concept. Abstraction is a process involving a great relative intensification of the focal element to the greater or less exclusion of the marginal elements—it is, therefore, essential to the development of concepts. There is no evidence to show that the lower animals can perceive relations or form concepts. And if we take "reason" as involving an apprehension of similarity of relation in things diverse, we have no evidence for the ascription of reason to animals other than man.

The three following chapters are rather metaphysical and philosophical than psychological. Chapter XVII expands the conception already outlined in the Prolegomena of subject and object as later differentiations of an originally homogeneous experience, and endeavors to identify that selective, synthetic, orderly and determinate activity which in the object we term the operation of natural law with that similar activity which in the subject we term Will. Self-consciousness in its most highly developed form involves "first, the conception of the subjective as distinguished from the objective; secondly, the concentration of the net result of all subjective experience into one generalized concept; and thirdly, the further conception of this net result as due to the determinate working of an activity which is synthetic and selective." This form of self-consciousness is attained by relatively few men; in the lower animals it is not probable that it exists at all.

Chapter XVIII takes up what in the Prolegomena is called the monistic interpretation of nature, and develops the conception of consciousness as a product of organic evolution. Chapter XIX, on "Selective Synthesis in Evolution," carries on in like manner the monistic analysis, endeavoring to trace throughout the inorganic and organic world the varying manifestations of that selective, synthetic activity which the monist regards as the ultimate essence of all.

Chapter XX and last, returns to psychology proper and compares the emotional and moral life of men and animals. The emotions of some of the lower animals are probably very like those of man. This is true especially of the offensive and defensive emotions, and to some degree of the sense of the beautiful. But there is no reason for

believing that brutes can form an aesthetic judgment or attain to an aesthetic or moral ideal.

It is not my intention to enter into any detailed criticism of Professor Morgan's book, yet there are some points which he will, I hope, make clearer in his forthcoming "Psychology for Teachers." I do not clearly see the laws by which the transition from the concrete to the general relation is effected; I would like to know why the word "concept" is to be restricted to generalized vector states and denied of analogous static states; I would like to see the doctrine of "automatic" centres and "control" centres brought more into harmony with the results of introspection; and I would like Professor Morgan to show why he identifies the selective, synthetic activity of nature, not only with the intrinsic properties of mental states, such as tendencies to development, to suggestion of ideas, to the production and prevention of muscular contraction, etc., which are its true analogues in the inner life, but also with that enigmatic activity of will, which seems at times to run counter to all these momenta and to determine thought and conduct in a fashion diametrically opposed to the provocation of the immediate environment. That this activity is without determinate laws I do not for a moment believe. It is probable that in it we see the present, conscious representative of our total individual and hereditary experience in some way brought to bear upon the immediate present. But as I do not think that even descriptive psychology can afford to ignore it, so I would not hastily identify it with any other phenomenon of inner or outer experience. That tendency to identify the energy or activity of the objective world with the "will" of the subjective world which has been more or less noticeable in philosophy since the days of Schopenhauer, is but a more refined form of the animistic theories of our prehistoric ancestors and of their successor, the theistic interpretation of nature which is still current. That there may be truth in such theories I am not prepared to deny, but as they cannot be tested by appeal to experience, nor are essential to the construction of a scientific conception of nature, they have at present no place in a reasoned scheme of knowledge.

One other point calls for comment. In his chapter on the physiological conditions of consciousness, Professor Morgan has, I think, failed to make use of the suggestive material brought to light by recent researches into what Pierre Janet calls "la désagrégation psychologique." It would, perhaps, be too much to say that the study of mental disorganization has established the possibility of mental states existing in connection with a given brain without forming part of the

"consciousness" normally related to that brain. But there is certainly much evidence for this hypothesis, and, if we adopt it, it would obviate all the verbal absurdities of "unconscious consciousness" and the sundry difficulties that attach to other theories. Moreover, the theory is directly in line with Professor Morgan's fundamental conceptions and I am rather surprised that he has not felt inclined to make more direct use of it.

Taken as a whole, Professor Morgan's book is without doubt the best introduction to psychology for mature minds that we possess. It is admirably clear, coherent and consistent. Notwithstanding his disclaimer of originality, in so far as regards his architectonic principles, it is not too much to say that he has succeeded in utilizing those principles for the organization of his bewilderingly complex material with greater success than has attended the efforts of either Professor James or Mr. Spencer. Many of us who are accustomed to use in teaching psychology the synthetic method which Professor James condemns so vigorously, have done so, not because we were especially wedded to the synthetic method as such, but because all attempts hitherto made to present the subject analytically only result in confusing the beginner. Professor Morgan's book seems to me the first successful attempt to make psychology intelligible by the analytic method, and I intend to try at once the experiment of using it as a text-book with beginners.

Furthermore, the book is most refreshingly free from the phraseology of the schools. The old tripartite division of the Englishmen and the "faculties" of popular superstition are conspicuous by their absence, and the reader is brought face to face with the facts. Throughout, the influence of Professor James' stimulating example seems traceable, but there is a consistency and precision in Professor Morgan's thought which one misses in Professor James'. It is true that precision and consistency in psychology can be attained, in the present state of the science, only by the sacrifice of much that the candid student would like to know, and a critical reader would doubtless sow Professor Morgan's pages thickly with interrogation points and carets. But the beginner needs most of all clearness, precision and substantial accuracy; the further processes of exception, modification and introduction of alternative theories are best deferred to a later stage. Professor Morgan has had the needs of the beginner in mind and has met them better than any contemporary writer.

ARCHEOLOGY AND ETHNOLOGY.[1]

The Antiquity of Man at Petit Anse (Avery's Island), Louisiana.—In digging fifteen and twenty feet through superficial soil into a very pure deposit of rock-salt, on a low hill at Avery's Island, west of New Orleans, some miners found, on the authority of Mr. T. F. Cleu (quoted by Professor Henry of the Smithsonian Insitution, Trans. Chic. Acad. of Sciences, Vol. I, part 2), a fragment of ancient cane matting near the top of the salt, and fourteen feet below the surface of the soil.

What made the discovery noteworthy was Mr. Cleu's statement (see Foster's Prehist. Races of the U. S., p. 56, and Nadaillacs Prehist. America, p. 36) that remains of the tusks and bones of a fossil elephant were found in the same soil two feet *above* the matting. Professor E. W. Hilgard and Dr. E. Fontaine afterwards (1867) said they found incredible quantities of pottery mixed with elephant and other large fossil bones at a depth of 12 feet below the surface.

By that time a good deal of digging for salt had been done in the mines by white men, and the investigators of the locality seem to have drawn their deductions from what they saw and what they heard from workmen in these pits. Some of the observers thought that the layer of loam covering the salt had been washed down from the surrounding hills. But its age would have been best settled by geological data of the bones it contained if the bones were in situ.

Whether the fossil bones were part and parcel of the loam or not, the important question is—were the human remains (basket work, pottery, etc.) contempory with the fossils, or were they not contemporary? And this has not been settled, for we do not know whether the comparatively modern Indians dug pits through the loam down to the salt just as the white men dig them now, and whether, in such case, their pottery and basket work finding a way naturally to the bottom of their pits, had not thus become mingled with an underplaced bed of animal remains already resting on the salt.

Comparatively recent peoples in Europe have dug graves and buried skeletons on cave floors so as sometimes to let down their relics into more ancient company when the graves happened to penetrate in-

[1] This department is edited by H. C. Mercer, University of Pennsylvania.

to older geological layers, and thus the most modern object in the world can be intruded into the most ancient stratum known.

Until this question of previous salt-pit digging by Indians is clearly settled, we must remain in the dark as to the meaning of the objects thus far found at Petit Anse.

The following notes upon a recent examination of the spot by the late Dr. Joseph F. Joor, has been kindly sent me by the President of Tulane University, of New Orleans.—H. C. MERCER.

Notes on a Collection of Archeological and Geological Specimens Collected in a Trip to Avery's Island (Petit Anse), Feb. 1st, 1890. By Joseph F. Joor, M. D.—About the end of January, 1890, President Johnston, of Tulane University, learned that the New Iberia Salt Co., in opening a new shaft, had exposed a number of Indian relics and remains of extinct animals. As the Professor of Geology could not then leave, he requested me to proceed at once to the spot, and secure as many specimens as possible for the University Museum; also to learn all I could of the Archaeology, Geology, and Natural History of the Island.

Accordingly, I left New Orleans, January 31st, reaching the Island the same evening. I was most agreeably and hospitably entertained by Mr. and Mrs. McIlhenny and the Avery brothers, who also gave me valuable assistance during the eighteen days' of my stay. The officers of the Salt Company also extended many courtesies, without which my work would have been greatly hindered.

The excavation formed a rectangle about 50 x 90 feet at top, and 30 x 70 at bottom, with sloping sides—the greater length being north and south. The depth to the salt varied from 16 to 25 feet. The layers penetrated at that time, at the northwest corner, were:

1st. Soil, 6 inches.

2d. Yellow clay, with some sand, 4–6 inches.

3rd. Black stiff loam, or swamp muck, 10–12 feet (pottery bed).

4th. Blue clay, with pebbles (bone bed), 2 feet or more.

This last was only partly removed at the time of my arrival, and from it came our paleontological specimens. Immediately below was the salt, with a very irregular surface, its hollows filled with the clay, which thus in some spots was nearly ten feet deep. The upper layers varied considerably in different parts, both in relative thickness and character. At the northeast corner, for instance, the yellow clay is partly replaced by sand. But the most important differences were in the loam. At the north end, near the northeast corner, a hollow,

probably the work of human hands, was scooped in the upper part of this layer to a depth of 3 or 4 feet, and completely filled with *ashes*, containing thousands of bits of pottery. One of the sloping approaches of the shaft was cut through this deposit, exposing a section about 10 or 12 feet long (north and south) by 4 or 5 feet wide, where it abutted on the main excavation. On the east side, 20 or 30 feet from the northern end, was another rounded hollow in the loam, 10 or 15 feet wide, where it was cut across, and 5 or 6 feet deep in the middle. This was filled with *sand*, mixed with black vegetable mold. At the north side of this, and extending into the adjacent part of the loam, were other bits of pottery, less numerous than in the ash bed, but in larger pieces. Here were found our largest specimens of earthenware.

Ten or twelve feet southwest of this last spot, and inside the rectangle of the shaft, was a live-oak stump, over 2 feet in diameter, and 3 or 4 feet high, with its roots still fast in the upper part of the loam on the east side, but tilted over to the west, as if it had been on a caving bank. The upper part of this was broken off as if by a tornado. The wood was still sound, and so tough as to necessitate the use of dynamite for its removal. It was considerably stained, as if by the infiltration of *iron*.

In the corner was what looked like a gully, 6 or 7 feet deep, hollowed in the loam, and filled with a mixture of ashes, sand and vegetable mould, with a few pieces of earthenware. Through this a pretty bold stream of water entered the excavation. All these inequalities in the loam were covered and approximately leveled by the yellow clay.

All of the larger pieces of pottery, and most of the smaller bits, were entirely destitute of ornamentation. Some of the lesser pieces, however, are marked with patterns of various kinds. Some show lines, generally oblique, apparently drawn with a pointed stick; others dots, looking as if they might have been made with a bit of cane. But some appear to have been *stamped*.

Our largest specimen represents rather less than half the circumference (at top) of a jar about 9 inches in diameter, and over a foot deep —the bottom entirely gone. It seems to have been somewhat narrowed below. This was broken into eight pieces in extricating it from the mud. Many of the other fragments indicate still larger vessels. They are all very thin and exceedingly fragile.

Before my arrival the workmen found two or three whole jars, which, however, were immediately smashed, probably from the idea that they contained treasure. Superintendent McCalla, however, rescued a large piece of one of them, which he presented to us. It is about half of the

lower segment of a jar nearly four inches in diameter, but narrowed at bottom. The fragment is about 5½ inches high. These jars were found near the oak stump.

Near the southern end of the excavation a piece of cane basket was exhumed. It was taken—still in the lump of mud—to Mr. E. McIlhenny, who still has it. It is of a very coarse make, and about 4 inches square. Mr. McIlhenny has given us the lump of mud with some bits of cane still sticking to it, and the impress of the remainder. It seems to have come from the lower part of the loam, below the level of most of the other human vestiges.

Mixed with the pottery everywhere were bones (mostly those of deer) with shells of a small tortoise, and of the same clam now found in Lake Ponchartrain—*Gnathodon cuneatus;* also a few mussels (Unio).

The loam was generally penetrated by small roots, most of them apparently those of marsh grasses or cane, with some of exogenous trees or shrubs. On the east side there were a good many leaves of live oak (*Quercus virens*), wax myrtle (*Myrica cerifera*) and others not identified. Some of these leaves (oak, myrtle and others) were *still green.* This phenomenon I can only explain by supposing the freshly fallen leaves to have been buried under a caving bank, and hermetically sealed by the stiff, waxy soil, which had never since become dry enough to admit the air. The leaves began to fade within half an hour, and in three hours had the ordinary brown color of a macerated leaf. They were seen while green by Manager John H. Hamilton and Mr Hausman of the mining company; Capt. Jas. Hare, of the U. S. Lighthouse Service, Mr. and Mrs. McIlhenny, Capt. Dudley Avery, and others.

We also found, at the same spot, some bent and twisted strips of bark, that were, perhaps, handles of baskets. They are badly decayed, however, and do not prove much.

The managers of the mine conjectured that the ash-bed marked the site of a pottery kiln, while the hollow in the loam on the east side was made by digging out material for the ware. But, to my eyes, the hollow looked more like the work of nature. I rather lean to the opinion that the ash-bed indicates a *furnace* for boiling down the brine of a salt spring, and that the pots were used for that purpose. Both theories may be correct.

I see no reason for assigning any very enormous antiquity to these relics. Most of them were covered by 5 or 6 feet of loam or less, and about the same of yellow, sandy clay and soil. The two last layers appear to be a "wash" from the neighboring hills, and may have been formed within a century, while three or four hundred years would be

enough for the loam, especially if there was a slight gradual subsidence, so as to keep it subject to overflow. The deeper specimens were found near the south end, where there are signs of a gully or hollow of some kind, which would fill more rapidly than the higher ground, if the cause which produced it were removed.

It is somewhat remarkable that not an arrow-head, weapon or tool was found in the excavation, although such articles are not rarely found at or near the surface, in the neighborhood.

In the blue clay, 16 to 20 feet from the surface, and immediately overlying the salt, were an immense number of bones. Unfortunately, most of these were badly decayed, and the clay very tenacious, so that most of them were destroyed. The Avery brothers, however, secured a good many of them, in the early stages of the work. Most of these they gave to Mr. McIlhenny, the rest to this University. I secured several hundred teeth, bones and (mostly) fragments, after reaching the ground. These represent the following animals:

A small Mastodon.

One or two species of Equus.

Mylodon harlanii.

Of these I am pretty certain. It is probable that there are also one, or possibly two, other Giant Sloths, a Deer, and possibly an Elephas. There are other remains which I cannot name, even conjecturally.

Of the Mastodon we have two teeth (one badly broken). Here also I place an atlas and a number of other vertebræ; but part or all of these may belong to Elephas. I was shown a tooth of that genus, said to have been found in this shaft. All these remains indicate an animal about 8 or 10 feet high.

To the Giant Sloth I have referred a fragment of an upper jaw, with an anterior molar in good order; another fragment of upper jaw much broken, with two molars and parts of two others; twenty-five detached teeth, many of them broken; two claw cores, nearly complete; a humerus, broken in two, with fragments of two other humeri; fragments of heads of two femurs; lower end of a tibia, and an astragalus. Here also I would place, very doubtfully, a number of vertebræ, with the visceral face of the body deeply excavated, as if for the lodgment of the aorta, with side channels leading right and left, as if for the passage of lateral branches.

I have referred most of these provisionally to *Mylodon harlanii*, as most of the teeth seem to belong to that species, while the claw cores are too much curved for Megatherium, and not enough curved for

Megalonyx. Some of the teeth, however, seem to belong to a different genus. Some years ago, Capt. Dudley Avery found a claw core, which he sent to the Smithsonian Institution, and which was there pronounced to be that of a Megalonyx. This was found near this spot, and in a deposit of the same age.

Part of the antler of a deer was found in the southeast corner of the excavation; but I am not certain whether it came from the blue clay, or from the much more recent deposit containing human vestiges, which here dips down almost to the level of the salt. In the blue clay, however, near this spot, we found vertebræ resembling those of a very large deer, with four molar teeth of some herbivorous animal, probably a ruminant, whose precise affinities are yet undetermined.

Among the miscellaneous specimens are water-worn fragments of coniferous wood, from the blue clay. These are in perfect preservation. There is also a soft stercoraceous mass, found about the junction of the blue clay and loam, apparently the dung of some large herbivorus animal.

MICROSCOPY.[1]

Preservation of some Marine Animals.—In 1891 there appeared a paper by T. Tullberg, *Ueber Konserviering v. Evertebraten in ausgedehnten Zustand*, in which a novel use of magnesium sulphate, or Epsom salts, was described. Tullberg was guided in his researches by the *a priori* consideration, that, as sea-water contains several salts in definite proportions, it is probable that marine animals would not contract if the proportion of one of the salts was increased, for the animal is already accustomed to these substances; and, on the other hand, it might have a toxic effect. Experimenting with Actinia, he finds that chloride of sodium has no effect, but with sulphate or chloride of magnesium the Actinian expands its tentacles, and after a certain time does not contract at all when its tentacles are pinched. He lets the Actinian expand in a vessel of sea-water, the quantity being determined so that the percentage of the salt added may be known. He then adds to the vessel a thirty-three per cent solution of magnesium chloride or sulphate until the water contains 1% of the salt. The additon is made slowly but is effected within half an hour, at the end of which time the Actinian is found to be anæsthetized. As a matter of fact only the exterior of the animal loses its sensibility.

It is then necessary to kill the animal which may be done by inundating it with some killing fluid, but in this case partial contraction may take place rendering it unfit for museum purposes. A better method is to kill it by slowly adding a 0·1% solution of chromic acid until the water contains from ·03% to ·05% of the acid. The results of this method are very satisfactory save that there is a decrease in the volume of the animal. Sections of the tentacles showed that the cells were not attacked by the substances employed.

This method was applied successfully to various fresh-water and salt-water invertebrates including various Actinians Holothurian, Turbellarians, Nemertines, Chætopods, Gasteropods, Ciona, etc. etc.

Last summer, through the kindness of Commissioner MacDonald, I had the opportunity of spending a few weeks at the U. S. Fish Commission laboratory at Wood's Hole, Mass., and obtained some interesting results with Epsom salts in the preservation of many of the marine invertebrates of that vicinity. The method of application requires modification in individual cases but a few experiments will usually en-

[1]Edited by C. O. Whitman, University of Chicago.

able one to obtain the desired results and in a much simpler manner than that described by Tullberg. Complete stupification of the organism must be produced, so that when it is removed to a killing fluid, no contraction will take place. Care should be exercised, however, not to carry on the process too slowly as maceration may ensue.

CŒLENTERATES.—The most beautiful results were obtained with sea-anemones which ordinarily are so difficult to preserve in a well expanded condition. These were allowed to expand in a dish with as little water as possible. Then crystals of magnesium sulphate were placed in the bottom of the dish and allowed to dissolve slowly until a saturated solution was obtained. The process of dissolving may be hastened if necessary by stirring up the water gently from time to time with a pipette. Several hours were required to completely stupify large specimens. When narcotization was complete, a few crystals placed in the mouth of the sea-anemone had no effect but if the process had not gone far enough the lips of the animal would slowly spread open and then would follow sometimes a violent contraction of the whole animal. This method was tried upon *Metridium marginatum*, *Sagartia leucolena* and *Halocampa producta* with excellent results, the tentacles remaining perfectly expanded after the animals had been transferred to Perenyi's fluid, picro-sulphuric acid or formalin. The same method applied to *Astrangea*, *Scyphistoma*, and various hydroids did not give as good results as those obtained with the sea-anemones. The polyps were not equally affected so that only portions of the colonies were perfectly expanded. A large Physalia treated in this way was preserved in 4% formalin with all the tentacles and polyps fully extended.

ECHINODERMS.—Star-fishes and sea-urchins were killed with the ambulacral feet and pedicellaria well extended, by placing them upon the aboral surface for a short time in a saturated solution of Epsom salts and then transferring them to 4% formalin. The epidermis of the star-fishes, however, was rendered soft and was subsequently easily rubbed off, but this was probably due to the formalin.

Specimens of *Synapta* were readily preserved without any constriction by very slowly and intermittently adding to the water, in which they had been allowed to expand, a saturated solution of $MgSO_4$.

VERMES.—Most annelids when placed in a saturated solution of Epsom salts, in a very short time became perfectly limp and were easily extended upon a glass plate and treated with a fixing reagent. *Balanoglossus*, when taken soon after being collected, was preserved in this manner in nearly a perfect state. It was necessary, however, to keep it in position between the edges of two glass slides when the fix-

ing fluid was applied. Good results were obtained with *Cirratulus, Amphitrite, Nereis, Rhyncobolus, Clymenella* and *Phascolosoma. Phascolosoma* in most cases was killed with tentacles protruded. *Nemertean* worms, when transferred to a killing fluid before being completely narcotized, sometimes protruded their probosces.

Ascidians.—*Molgula* and *Cynthia* were readily killed with siphons open after anæsthetization with magnesium sulphate. In this case it is best to add the saturated solution of sulphate intermittently with a pipette.

Ctenophores.—After considerable experimentation a method for preserving these delicate creatures in a nearly life-like appearance was devised. Formalin alone in solutions of varying strength had been tried without success. It was found necessary to treat the animals with some hardening reagent before placing them in the formalin and the following method seems to be the most successful. To a solution of equal parts of 2% formalin and Perenyi's fluid was added enough common salt (NaCl) to increase the density of the mixture to that of sea-water, i. e., until a Ctenophore placed in it barely floated. This adjustment of the density of the surrounding medium prevented the Ctenophores from collapsing of their own weight. After remaining for about half an hour in this fluid, they were transferred to 4% formalin, the density of which had been increased by the addition of either Epsom salts or common salt so that the Ctenophores again barely floated. Epsom salts is probably better than common salt for increasing the density of the fluid. Some specimens which were preserved in formalin+NaCl began to shrink after a few days, while some (Mnemiopsis) which have been preserved for nearly six months in formalin+$MgSO_4$ are still in excellent condition.

After the Ctenophores have been properly preserved, precaution must be taken in transporting them, for they are easily torn to pieces. If they are placed in bottles filled with fluid of the proper density and the cork so inserted as to leave no air bubbles, this danger is reduced to a minimum.—W. A. Redenbaugh, Dartmouth Coll., Hanover, N. H.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

National Academy of Sciences.—A special stated session of the Academy met on Saturday, February 9th, 1895, in New York City, at Columbia College, to consider the Report of the Committee on Electrical Units. The report was adopted and was ordered to be transmitted to Congress.

Boston Society of Natural History.—January 16.—The following papers were read: Prof. E. S. Morse, "Korean Interviews;" Mr. Percival Lowell, "Korea and the Koreans."

February 20th.—The following paper was read: Prof. Edmund B. Wilson, "Karyokinesis and the Fertilization of the Ovum;" illustrated by stereopticon views photographed directly from the eggs of the sea-urchin (*Toxopneustes variegatus*).

March 6th.—The following papers were read: Mr. L. S. Griswold, "The Geographical History of the Lower Mississippi;" Mr. C. F. Marbut, "Some Features of the Coastal Plain in the Mississippi Embayment;" Mr. Cleveland Abbe, Jr., "Note on Cusped Sand-bars of the Carolina Coast."—SAMUEL HENSHAW, *Secretary.*

The Biological Society of Washington.—February 9th.—The paper of the evening was "Explanation of Immunity from Infectious Diseases," by Surg.-Gen'l George M. Sternberg, U. S. A.

February 23d.—The following communications were made: Prof. Lester F. Ward, "Archetypal Angiosperms;" Prof. F. E. L. Beal, "Food Habits of Woodpeckers;" Mr. F. A. Lucas, "Some Abnormal Feet of Mammals;" Mr. M. B. Waite, "Notes on the Flora of Washington."—FREDERIC A. LUCAS, *Secretary.*

Nova Scotian Institute of Science.—February 11th—The following papers were read: "The Iron Ores of Nictaux N. S., with Notes on the Manufacture of Steel in Nova Scotia," by Edwin Gilpin, Jr., Esq., LL. D., F. G. S., Inspector of Mines; "Geological Notes on the Nictaux Iron Fields," by A. H. MacKay, Esq., LL. D., F. R. S. C., Superintendent of Education.—HARRY PIERS, *Secretary.*

New York Academy of Sciences. Biological Section.—February 11th, 1895.—The following papers were presented: Dr. Albert Schneider, "The Occurrence and Functions of Rhizobia;" a

discussion of the discovery of the adaptability of rhizobia to other plants than leguminous. Some conclusions based upon investigations carried on at the Illinois experiment station were given to show that it is probable that rhizobia may be so modified as to grow in and upon roots of gramineous plants (ex. Indian corn). Prof. N. L. Britton, "An Undescribed Ranunculus from the Mountains of Virginia;" Dr. J. L. Wortman, "On the So-called Devil's Corkscrews of Nebraska." A visit to the locality during the past summer had enabled him to study many problems in connection with their occurrence, which tend to throw considerable light upon their nature. The formation in which they occur was positively identified as the Loup Fork division of the upper Miocene, which is a true sedimentary deposit. The Daemonelix occurs in a stratum of from 50 to 75 feet in thickness, always standing vertically, and their tops are not confined to any one level. They vary much in size and character, but, so far as observed, always present the spiral twist. The fact that they occur in true sedimentary rocks, that their tops occupy many levels, together with the lack of evidence to show that there was any disturbance of level during the time the sediment was being laid down, was considered to totally disprove the theory that they represent the burrows of animals which has been so extensively held in explanation of their curious nature. The invariable presence of plant-cells, together with other facts, leads to the conclusion that they very probably represent the remains of roots or stems of some gigantic water plant.

"The Excretory System of Clepsine and Nephelis," by Dr. Arnold Graf. The results of H. Bolsius have proved to be erroneous. The different parts of the nephridium are classified as follows: 1. *Infundibulum*, consisting in Nephelis of six bilobed ciliated cells, in *Clepsine* of a peduncle cell, pierced by a ciliated canal, and two bilobed ciliated cells attached to the peduncle. 2. *Receptaculum excretorium* A vesicle which is in open communication with the funnel and in osmotic communication with the following parts of the nephridium. It is similar in both genera, and filled with disintegrating material. 3. *Portio afferentia.* The part of the gland, consisting of a single row of round cells, pierced by a sometimes bifurcated canal, which gives off branched side canals. Similar in both genera. 4. *Portio glandulosa.* Row of cells, pierced by a smooth canal without side branches of bifurcation. This part is the largest part of the whole organ. Similar in both genera. 5. *Vesicula terminalis.* In *Nephelis*, a vesicle, lined by a ciliated epithelium; in *Clepsine*, a simple pouch of the *epidermis*, without cilia. 6. *Canalis terminalis.* The short canal by which the termi-

nal vesicle communicates with the exterior. Present in *Nephelis*. In *Clepsine* it is equivalent to the terminal vesicle.

The cells formerly called Chloragogencells, should now be called *Excretophores*. A preliminary about these cells has been sent to the "Zoologischer Anzeiger." The investigation had been carried out mainly on living tissues, and every source of error had been eliminated.

—BASHFORD DEAN, *Secretary*.

SCIENTIFIC NEWS.

John A. Ryder, Professor of Histology and Embryology in the School of Biology of the University of Pennsylvania, died on March 26th. He was born in 1852 near Linden in Franklin Co., Pennsylvania, of old "Pennsylvania German" stock, and displayed a strong predilection as a small boy for the study of nature. At school he was persistent in the pursuit of his favorite subject, and took little part in the sports and quarrels of the boys with whom he was associated. His sensitiveness to their criticisms was such that he ran away from school, only to devote himself more fully to study. He came to Philadelphia and was soon deep in microscopic work. At that time the methods of preparation of objects for the microscope were not as well understood as they have since become, and Ryder invented most of the methods which he used in his first researches. His studies of the embryology of fishes led to his appointment on the U. S. Fish Commission, where he published a number of important papers on the embryology of fishes and mollusca, and among the latter, the oyster was an especial object of investigation. In 1886 he was appointed to the position which he held at the time of his death. Professor Ryder was an indefatigable investigator, and his published papers, though numerous, give little idea of his activity. He has left behind him manuscript of considerable importance, which it is to be hoped will be published with the aid of a worthy editor. He was for a considerable time editor of the department of embryology of the American Naturalist.

Besides excellent powers of observation, Professor Ryder had a mind naturally capable of comprehending mechanics. He patented several inventions of economic value. This tendency is to be seen especially in his application of mechanics to the problems of evolution, in which he presented many original ideas. He was a strong supporter of the Neolamarkian school; and he carried this hypothesis into the explanation of histogenesis with more success than any American,

and he had few if any equals in Europe. At the same time he cannot be said to have had a very systematic mind. He was an excellent delineator of natural objects. Personally, he was a most amiable man, and he endeared himself to his colleagues and pupils. He leaves a widow.

Dr. William S. W. Ruschenberger died March 25th, 1895, in his 88th year. He was born in Cumberland County, New Jersey, September 4, 1807. After receiving an academic education in Philadelphia and New York schools, he entered the medical service of the United States navy as a surgeon's mate, August 10, 1826.

His medical tutors were Dr. J. P. Hopkinson and Dr. Nathaniel Chapman, of the Medical Department of the University of Pennsylvania, from which he received the degree of Doctor of Medicine in March, 1830. He was commissioned a surgeon in the navy April 4, 1831, and from 1835 to 1837 was Fleet Surgeon to the East India Squadron, with which he circumnavigated the globe. In 1840-42 Dr. Ruschenberger was attached to the naval rendezvous in Philadelphia. From 1843 he was Superintendent of the United States Naval Hospital at Brooklyn, and during his term of service there organized the Naval Laboratory, for supplying the service with pure drugs. He was again Fleet Surgeon of the East India Squadron from 1847 to 1850, Fleet Surgeon of the Pacific Squadron from 1854 to 1857, and of the Mediterranean Squadron from August, 1860, to July, 1861, having served in the intervals between cruises at Philadelphia.

During the civil war Dr. Ruschenberger was surgeon of the Boston Navy Yard. From 1865 to 1870 he was on duty in Philadelphia. From 1866 to the time of his retirement, September 4, 1869, he was the senior officer in the Medical Corps, and March 3, 1871, he was commissioned Medical Director on the retired list, with the relative rank of Commodore.

Dr. Ruschenberger was for several years President of the Academy of Natural Sciences of Philadelphia. His long service as an officer in the navy did not, however, qualify him for corresponding positions in civil life. His habit of enforcing technical discipline was offset by a courteous and affable bearing. He wrote several books describing his travels, and a primary school-book of Natural History, which was the first one of the kind in the country, and was of considerable service to men now in middle life.

The Laboratory at Cold Spring Harbor.—The laboratory has experienced some difficulty in the past years in properly accommodating

its students with lodging places. For this reason the need of a dormitory has been seriously felt for the last two years. The Wawepex Society has recently decided to erect such a dormitory and this building will be begun and finished during the coming spring, so as to be in condition for use during the coming session of 1895. The attempt will be made to furnish comfortable rooms to students at a very nominal price.—H. W. CONN.

The Biological Survey of Indiana.—Special efforts are now being made to make a Biological Survey of the state, the object being: (1) To ascertain the character and extent of the life of the state. (2) To associate the various workers throughout the state so that they all may labor toward the same end. (3) To stimulate the teachers of biology to encourage in their students the accumulation of material. (4) To secure for the Academy a collection that will illustrate the biology of the state.

Three directors have general charge of this work. Prof. Underwood in charge of the botanical division made a very encouraging report of the work in that field. The other directors made no report.

The Academy took an advance step in arranging matters to ask the state legislature to publish its Proceedings. Heretofore, the Academy has had to meet this expense.

The Spring meeting of the Academy will be held at the Wyandotte Cave in Crawford County.—A. J. BIGNEY, *Asst. Sec.*

Summer Course at the University of Pennsylvania.—The Department of Biology, in the Summer Meeting of 1895, will be under the immediate direction of Dr. William P. Wilson, Professor of Botany in the University of Pennsylvania, and Director of the newly established Philadelphia Museums. The lectures and laboratory work of the courses in the Biological Department have been arranged with a view to the needs of teachers in general, and of the teachers of Philadelphia in particular. They will aim to suggest much new material for study in the school-room, to give information concerning it, the best and most modern methods of using it for nature study, and also such technical training in the use of the microscope, etc., as will enable those who complete the course to continue their work in the University. The lectures in the various courses will be fully illustrated by natural objects, charts, diagrams, and by lantern.

The courses will be elementary, and no special preparation on the part of the student will be pre-supposed. Advanced instruction will

be given for those who are ready for it. There will be lectures and laboratory work amounting to about five and a half hours per day during the entire month.

The laboratories and equipment of the University are placed fully at the disposal of the department, for the use of students. The tuition fee in the Department of Biology is ten dollars, with a special laboratory fee of two dollars. Unusually good facilities are thus afforded at a merely nominal cost.

The instruction will consist of three five-lecture courses in Botany, by Professor Macfarlane, Professor Halsted and Professor Wilson; two five-lecture courses in Zoology, by Professor Cope and Professor Ryder's successor; lectures on special topics by eminent biologists; thirty hours laboratory practice in Biology, and five lectures by Mrs. Wilson on Biology from the standpoint of teachers in the elementary schools.

Among the lectures on special topics are: Professor Liberty H. Bailey, of Cornell University, who will deliver two lectures on "How Garden Varieties Originate: a Study in Evolution;" Professor George L. Goodale, of Harvard University, who will deliver an address before the students of all departments on "The Relations of Certain Plants to Political Economy;" Professor Byron D. Halsted, of Rutgers College, whose lectures are ontlined below, and Professor Charles O. Whitman, of the University of Chicago.

A new scientific society has been organized in the Jardin des Plantes, which will hold its meetings the last Thursday of each month. It is composed of the scientific personel of the Museum and has for an aim to bring about a knowledge and a cordial interest in each other's work. It is thought that the discussion of papers presented to the society from various points of view of specialists, in the different fields of biology, will be both interesting and profitable. (Revue Scientifique, Feb. 1895.)

The Academy of Natural Sciences of Philadelphia have voted the Hayden medal to Professor G. A Daubrée, member of the Académie des Sciences in Paris, and Professor of Mineralogy in the École des Mines. Prof. Daubrée's researches into the intricate causes of crystalline structure are important contributions to scientific knowledge as are also his expositions of experimental geology.

The Belgian Academy of Science in Brussels has offered prizes to the value of six hundred francs for the best treatise on one of the following subjects: (1) Researches on the number of chromosomes, be-

fore fertilization, in an animal or a plant. (2) New researches on the Quaternary flora, especially on peat-mosses. (3) Is there a nucleus in Schizophytes? If so, what is its structure and the mode of its division? The author must give a critical résumé of all work hitherto published on this subject. Treatises should be written in French or Flemish, and sent with motto and sealed name to Chev. Edm. Marchal, Secretary of the Academy, before August 1, 1895.

Erratum to be made in "An Abnormal Pes of Columbia livia," by S. D. Judd, "AMERICAN NATURALIST" Jan. '95. Plate VI. The left of the two upper drawiugs was published by mistake, the right of these two drawings should have been labeled "Fig. 2," The remaining skeleton drawing should have been labeled "Fig. 1." Of the two drawings representing feet in toto, the one to the left of the page should have been labeled "Fig. 4," the other "Fig. 3." Explanation of Figures. For Plate I read Plate VI. For XI read times 1=natural size.

List of Errata in Article, Insanity in Royal Families, American Naturalist, February, 1895.—P. 119, lines 14–15, for more direct read direr; P. 119, line 25, for jealously read jealousy; P. 119, line 33, for May read Mary; P. 120, line 2, for and read in; P. 120, line 34, for the read his; P. 120, line 34, for to, read of; P. 122, line 6, for brother read father; P. 124, line 23, for goes, read exists; P. 129, line 17, leave out comma after at.

Erratum.—In No. 329, May, 1894, on p. 439, first line, read Otto Maas in place of Otto Wass.